Naval Reactors

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Proposed Appropriation Language

For Department of Energy expenses necessary for naval reactors activities to carry out the Department of Energy Organization Act (42 U.S.C. 7101 et seq.), including the acquisition (by purchase, condemnation, construction, or otherwise) of real property, plant, and capital equipment, facilities, and facility expansion, and [the purchase of not to exceed one bus, $766,400,000] $797,900,000, to remain available until expended.

Explanation of Change

Changes from the language proposed in FY 2004 consist of a change to the number of proposed motor vehicles and funding amounts.

Naval Reactors

Funding Profile by Subprogram

(dollars in thousands)

	FY 2003 Comparable Appropriation	FY 2004 Original Appropriation	FY 2004 Adjustments	FY 2004 Comparable Appropriation	FY 2005 Request
Naval Reactors Development (NRD)					
Operations and Maintenance	666,927	723,100	- 4,264	718,836	761,211
Program Direction	24,043	26,700	- 148	26,552	29,500
Construction	11,226	18,600	- 110	18,490	7,189
Subtotal, Naval Reactors Development	702,196	768,400	- 4,522	763,878	797,900
Less Use of prior year balances	0	- 2,000		- 2,000	0
Subtotal Adjustments	0	0	0	0	0
Total, Naval Reactors	702,196	766,400	- 4,522	761,878	797,900

FYNSP Schedule

(dollars in thousands)

	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FYNSP Total
Naval Reactors	797,900	803,000	818,000	834,000	850,000	4,102,900

Public Law Authorization:
Pub. L. 83-703, "Atomic Energy Act of 1954"
"Executive Order 12344 (42 U.S.C. 7158), "Naval Nuclear Propulsion Program"
Pub. L. 107-107, "National Defense Authorization Act of 2002", Title 32, "National Nuclear Security Administration"

FY 2003 Execution

(dollars in thousands)

	FY 2003 Approp	General Reduction	Rescission	Supplement	Reprogram-ming	Comp Adjustment	Current FY 2003 Comparable
Naval Reactors							
NR O&M	671,290	0	- 4,363	0	0	0	666,927
Construction	11,300	0	- 74	0	0	0	11,226
NR Program Direction	24,200	0	- 157	0	0	0	24,043
Total, Naval Reactors	706,790	0	- 4,594	0	0	0	702,196

FY 2004 Appropriation

(dollars in thousands)

	FY 2004 Enacted Approp	Use of Prior Year Balance	Pending Rescis-sion	Supple-mental	Reprogram-ming/Trans-fers	Comp Adjustments	Current FY 2004 Comp
Naval Reactors O&M	723,100	0	-4264	0	0	0	718,836
Construction	18,600	0	-110	0	0	0	18,490
NR Program Direction	26,700	0	-148	0	0	0	26,552
Subtotal, Naval Reactors	768,400	0	-4,522	0	0	0	763,878
Use of prior year balances	-2,000	0	0	0	0	0	-2,000
Total, Naval Reactors.......	766,400	0	-4,522	0	0	0	761,878

Description

Mission

Provide the Navy with safe, militarily effective nuclear propulsion plants and ensure their continued safe and reliable operation.

Benefits

As the post-Cold War era evolves, the NNSA is working to provide the U.S. Navy with nuclear propulsion plants that are capable of responding to the challenges of the 21^{st} century security environment.

Program Goal: The Naval Reactors program has one program goal which contributes to General Goal 3 in the "goal cascade":

General Goal 3, Naval Reactors: Provide the Navy with safe, militarily effective nuclear propulsion plants and ensure their continued safe and reliable operation.

Contribution to General Goal 03

Within the Naval Reactors program, the Plant Technology, Reactor Technology and Analysis, Materials Development and Verification, Evaluation and Servicing, Facility Operations, Construction, and Program Direction subprograms each make unique contributions to Program Goal 03.49.00.00.

Naval Reactors is responsible for all naval nuclear propulsion work, beginning with technology development, continuing through reactor operation and, ultimately, reactor plant disposal. The Program ensures the safe operation of reactor plants in operating nuclear-powered submarines and aircraft carriers (constituting 40 percent of the Navy's combatants), and fulfills the Navy's requirements for new nuclear propulsion plants that meet current and future national defense requirements.

Naval Reactors is principally a technology program in the business of power generation for military application. The Program's development work ensures that nuclear propulsion technology provides options for maintaining and upgrading current capabilities, as well as for meeting future threats to U.S. security. As advances in various functional disciplines coalesce, work is integrated into the technology applicable to a naval nuclear plant. The presence of radiation dictates a careful, measured approach to developing and verifying nuclear technology, designing needed components, systems, and processes, and implementing them into existing and future plant designs. Intricate engineering challenges and long lead times to fabricate the massive, complex components require many years of effort before technological advances can be introduced into the Fleet.

The Program's number-one priority is ensuring the safety and reliability of the 103 operating naval reactor plants. Most of the work within the Naval Reactors Program is directed toward ensuring the safe, reliable operation of these plants. Naval Reactors is continuing development of a high energy reactor for CVN 21 and design of the new Transformational Technology Core (TTC), which will provide a significant energy increase to VIRGINIA-class ships.

Nuclear power enhances warship capability and creates the flexibility needed to sprint anywhere in the world and arrive ready for around-the-clock power projection and combat operations. Sustained high-speed capability (without dependence on a slow logistics train) enables rapid response to changing world circumstances, allowing operational commanders to surge these ships from the United States to trouble spots or to rapidly redeploy them from one crisis area to another. Nuclear propulsion helps the Navy stretch available assets to meet today's worldwide national security commitments.

The nuclear propulsion plant design of CVN 21 is well underway. The new high energy reactor design for CVN 21 represents a critical leap in capability; not only will the CVN 21 reactor enable the Navy to meet current forecasted operational requirements, but just as importantly, it will provide flexibility to deal with unanticipated warfighting needs in the future. The CVN 21 reactor will provide greater than 25 percent more energy than the reactors in NIMITZ-class ships. This propulsion plant will have substantially more electrical generating capacity than NIMITZ-class ships, but will require just half the number of sailors to operate and will be easier to maintain. The extra energy will support higher operational tempos or longer reactor life in the CVN 21-class.

The CVN 21-class lead ship is expected to be authorized in 2007 and to go to sea in 2014.

To meet ever increasing national security demands, Naval Reactors is working on TTC to deliver a significant energy increase to future VIRGINIA-class ships with minimum impact to the overall ship design. TTC is a direct outgrowth of the Program's advanced reactor technology work and will not only help meet national security demands, but will also act as a stepping stone for future reactor plant development.

Long-term Program goals have been to increase core energy, to achieve life-of-the-ship cores, and to eliminate the need to refuel nuclear powered ships. Although efforts associated with this objective have resulted in planned core lives that were sufficient for the 30-plus year submarine (based on past usage rates) and an extended core life planned for CVN 21, fleet size is down and national security demands require a higher operating tempo and greater speed during deployments. Since September 11, 2001, submarine operating requirements have increased by 30 percent. Continuing this pace will reduce the expected core life to less than 30 years.

TTC will offset the increasing national security demands by using advanced reactor core materials to achieve a significant increase to the core energy density—more energy without increasing size, weight or space while still at a reasonable cost. With significantly more energy, the objective for TTC is to do one or more of the following: extend ship life by as much as 30 percent; increase operating hours per operating year; or allow operation at a higher average power during ship operations. The end result is significantly greater operational ability and flexibility.

The timing of TTC development also corresponds with the need to transition from 97 to 93 percent enriched Uranium fuel. This transition is necessitated by the shutdown of the high enrichment plant and the decision to use Uranium recovered from retired nuclear weapons as starter material for naval nuclear reactors.

TTC is intended for forward-fitting into VIRGINIA-class submarines, which is planned to be the mainstay of the submarine fleet in future decades. TTC development should support procurement of a prototypic core in about FY 2008. In FY 2005, Naval Reactors will complete TTC core conceptual design and initiate final design and development work.

Annual Performance Results and Targets

FY 2000 Results	FY 2001 Results	FY 2002 Results	FY 2003 Results
Ensure the safety, performance reliability, and service-life of operating reactors. (MET GOAL).	Ensure the safety, performance, reliability, and service-life of operating reactors for uninterrupted support of fleet demands, including maintaining utilization factors of at least 90 percent for test reactor plants, and 121 million miles steamed for nuclear-powered ships. (MET GOAL)	Naval Reactors safely steamed over two million miles in nuclear–powered ships. (MET GOAL) Naval Reactors exceeded a 90% utilization factor for operation of test reactor plants. (MET GOAL)	Completed safe steaming of approximately two million miles in nuclear-powered ships. (MET GOAL) Achieved a utilization factor of at least 90% for operation of test reactor plants. (MET GOAL)
Develop new reactor plants, including the next generation reactor, the design of which will be 90 percent complete by the end of FY 2000, and complete initial development efforts on a reactor plant for the next generation aircraft carrier. (MET GOAL)	Develop new technologies, methods and materials to support reactor plant design, including the next generation submarine reactor, which will be 93 percent complete by the end of FY 2001 and initiate detailed design efforts on a reactor plant for the next generation aircraft carrier. (MET GOAL)	Next-generation submarine reactor design 96% complete. (MET GOAL) Next-generation aircraft carrier reactor design 40% complete. (MET GOAL)	Next-generation submarine reactor design 99% complete. (MET GOAL) Next-generation aircraft carrier reactor plant design 55% complete. (MET GOAL)
Ensure radiation exposures to workers or the public from Naval Reactors' activities is within Federal limits and no significant findings result from environmental inspections by State and Federal regulators. (MET GOAL)	Maintain outstanding environmental performance by ensuring that no personnel exceed Federal limits for radiation exposure, and no significant findings result from environmental inspections by State and Federal regulators. (MET GOAL)	No personnel exceeded 5 REM/year. (MET GOAL) Operations had no adverse impact on human health or the quality of the environment. (MET GOAL)	No personnel exceeded 5 REM/year. (MET GOAL) Operations had no adverse impact on human health or the quality of the environment. (MET GOAL)

Annual Performance Results and Targets

Performance Indicators	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	Endpoint Target Date
Miles of safe reactor plant operation supporting National security requirements.	Completed safe steaming of approximately two million miles in nuclear-powered ships.	Complete safe steaming of approximately two million miles in nuclear-powered ships.	Complete safe steaming of approximately two million miles in nuclear-powered ships.	Complete safe steaming of approximately two million miles in nuclear-powered ships.	Complete safe steaming of approximately two million miles in nuclear-powered ships.	Complete safe steaming of approximately two million miles in nuclear-powered ships.	Complete safe steaming of approximately two million miles in nuclear-powered ships.	Complete safe steaming of approximately 130 million miles in nuclear-powered ships in FY 2005.
Utilization factor for operation of test reactor plants. (EFFICIENCY MEASURE)	Achieved a utilization factor of at least 90 percent for operation of test reactor plants.	Achieve a utilization factor of at least 90 percent for operation of test reactor plants.	Achieve a utilization factor of at least 90 percent for operation of test reactor plants.	Achieve a utilization factor of at least 90 percent for operation of test reactor plants.	Achieve a utilization factor of at least 90 percent for operation of test reactor plants.	Achieve a utilization factor of at least 90 percent for operation of test reactor plants.	Achieve a utilization factor of at least 90 percent for operation of test reactor plants.	N/A
Percent of completion on the Transformational Technology Core (TTC) reactor plant design.		Establish design basis from preliminary studies and development to enable the start of conceptual design.	Complete TTC core conceptual design and initiate final design and development work.	Complete 50% of TTC design work to support core contract placement. Establish steam generator design configuration to support TTC core performance improvements.	Complete all TTC design and development necessary to place core fabrication contract in FY08.	Release fabrication of fuel and poison elements for the TTC core.	Initiate core production and perform higher-tier qualification work.	The TTC development will support procurement of a prototypic core in FY08 and deliver the first TTC core in 2014.
Percent of completion on the next-generation aircraft carrier reactor plant design.	Next-generation aircraft carrier reactor design 55% complete.	Next-generation aircraft carrier reactor design 60% complete.	Next-generation aircraft carrier reactor design 70% complete.	Next-generation aircraft carrier reactor design 75% complete.	Next-generation aircraft carrier reactor design 80% complete.	Next-generation aircraft carrier reactor design 85% complete.	Next-generation aircraft carrier reactor design 90% complete.	The next-generation aircraft carrier will go to sea in 2014.
Percent of completion on the next-generation submarine reactor plant design.	Next-generation submarine reactor 99% complete.	Complete 100% of the next-generation submarine reactor design.						The next-generation submarine will go to sea in 2004.

Performance Indicators	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	Endpoint Target Date
Ensure no one exceeds Federal limits for personnel radiation exposure from Program operations.	No personnel exceed 5 rem/year.	No personnel exceed 5 rem/year.	No personnel exceed 5 rem/year.	No personnel exceed 5 rem/year.	No personnel exceed 5 rem/year.	No personnel exceed 5 rem/year.	No personnel exceed 5 rem/year.	N/A
Ensure Program operations have no adverse impact on human health or the quality of the environment.	Operations had no adverse impact on human health or the quality of the environment.	Operations have no adverse impact on human health or the quality of the environment.	Operations have no adverse impact on human health or the quality of the environment.	Operations have no adverse impact on human health or the quality of the environment.	Operations have no adverse impact on human health or the quality of the environment.	Operations have no adverse impact on human health or the quality of the environment.	Operations have no adverse impact on human health or the quality of the environment.	N/A

Means and Strategies

The Naval Rectors program will use various means and strategies to achieve its program goals. However, various external factors may impact the ability to achieve these goals. The program also performs collaborative activities to help meet its goals.

The Department uses two Government-owned, contractor-operated laboratories, the Bettis and Knolls Atomic Power Laboratories, which are solely dedicated to naval nuclear propulsion work. Through these laboratories and testing conducted at the Advanced Test Reactor (ATR) located at the Idaho National Engineering and Environmental Laboratory (INEEL), the Department will complete scheduled design, analysis and testing of reactor plant components and systems, and will conduct planned development, testing, examination, and evaluation of nuclear fuel systems, materials, and manufacturing and inspection methods necessary to ensure the continued safety and reliability of reactor plants in Navy warships. The Department will also accomplish planned testing, maintenance and servicing at land-based prototype nuclear propulsion plants, and will execute planned inactivation of shutdown, land-based reactor plants in support of environmental cleanup goals. Finally, the Department will carry out the radiological, environmental and safety monitoring and ongoing cleanup of facilities necessary to protect people, minimize release of hazardous effluents to the environment, and comply with all applicable regulations.

Industry-specific business conditions, outside technological developments and Department of Navy decisions all impact the performance of naval nuclear propulsion work.

Naval nuclear propulsion work is an integrated effort involving the DOE and the Navy, who are full partners in the Naval Nuclear Propulsion Program. This relationship is set forth in the Executive Order 12344 and Title 42 U.S.C. 7158.

Validation and Verification

NNSA uses extensive internal and external reviews to evaluate progress against established plans. NR plans semi-annual reviews of performance measure execution in addition to monthly financial and technical work reviews with the M&O contractors. NNSA's programmatic activities are subject to continuing review by the Congress, the General Accounting Office, the Department's Inspector General, the National Security Council, the Defense Nuclear Facilities Safety Board, the Department's Office of Engineering and Construction Management, and the Department's Office of Independent Oversight and Performance Assurance.

Funding by General and Program Goal

(Dollars in Thousands)

	FY 2003 Approp	FY 2004 Approp	FY 2005 Request	FY 2006	FY 2007	FY 2008	FY 2009
General Goal 3: NAVAL REACTORS	702,196	761,878	797,900	803,000	818,000	834,000	850,000
Program Goal 3-49-00-00	702,196	761,878	797,900	803,000	818,000	834,000	850,000

NR Strategies

The following six strategies support Naval Reactors' program goal and are integrated into the detailed program justifications within the budget. Thus, within each component of the Detailed Program Justification, Naval Reactors identifies the relevant strategies from the following list, the principal activity areas which exist within each strategy (summarized below), and verifiable supporting activities for each area.

1. **Conduct planned development, testing, examination and evaluation of nuclear fuel systems, materials, and manufacturing and inspection methods to ensure naval nuclear reactors are able to meet Navy goals for extended warship operation.**

As national security demands increase with a smaller submarine fleet, each ship must carry more of the burden, be on line more of the time, and stay in service longer. Examples of the increasing demands can be seen in the operating tempo required to support military requirements worldwide to protect our country from serious threats from hostile nations and organizations without fixed borders.

To support these operational demands, materials, components, and systems must be operationally reliable for longer periods than ever before. For example, plants originally designed for a twenty-year service life are now being called upon to serve up to about fifty years. Exhaustive testing, analysis, performance enhancements, and development efforts are needed so that component and system endurance—despite mechanical strain and wear, and potential corrosion due to stress and irradiation—can be ensured throughout an extended lifetime. Additionally, to meet the ever-increasing national security demands, Naval Reactors has begun preliminary design studies on the Transformational Technology Core (TTC). TTC is a direct outgrowth of the Program's advanced reactor technology work and will not only help meet national security demands, but will also act as a stepping stone for future reactor plant development.

Development efforts to date have yielded significant advantages. Enhanced component reliability and improved predictive techniques have allowed the Navy to extend the intervals between major maintenance periods, increasing ship on-line time and, thus, the Navy's war fighting capability, while reducing cost. However, these advancements also generate new challenges. For example, the longer intervals between maintenance periods reduce opportunities to examine and/or replace aging components and systems. Thus, more extensive analysis and testing are required to verify materials and component performance. In a similar vein, development of a life-of-the-ship core offers major advantages in terms of ship availability, as well as reducing cost, radiation exposure and waste generation; but a life-of-the-ship core also reduces mid-life opportunities to examine components and help ensure integrity. Testing and verification, therefore, are of paramount importance.

These efforts are especially challenging given the demanding nature of nuclear propulsion technology. Components and materials must perform reliably within the harsh environment of a reactor plant. Comprehensive and rigorous analyses are needed to ensure the ability to withstand the deleterious effects of wear, corrosion, high temperature, and pressure over a lifetime measured in decades. In addition, naval reactor plants must be rugged enough to accommodate ships' pitching and rolling; have the resilience to respond to rapidly-changing demands for power; be robust enough to withstand the rigors of battle; and be safe and easily maintainable for the sailors who live next to them.

The following are principal activity areas for this strategy:

- Improve nuclear heat source (core) design and analysis methods and develop improved designs to satisfy service life requirements.
- Evaluate and test improved core manufacturing processes and inspection techniques to support extended life reactors.
- Examine fuel cells removed at the end-of-life, and perform non-destructive examinations of irradiated test specimens to confirm predicted performance and validate design methods.
- Develop improved nuclear fuel, core and reactor structural materials which extend core lifetimes up to the life of the ship, and evaluate irradiation tests of new and existing materials to verify acceptable lifetime performance and to improve predictive capabilities.
- Test and evaluate plant materials to characterize the long-term effects of the harsh operating environment, and qualify improved materials and processes to ensure endurance requirements will be met.
- Conduct irradiation testing and perform detailed examinations to provide data for material performance characterization and prediction.

2. Complete scheduled design, analysis, and testing of reactor plant components, systems, and performance to ensure the operational safety and reliability of reactor plants for use in Navy nuclear powered warships so they can fulfill their national defense mission.

Naval Reactors is responsible for the operation of 103 reactors—equal to the number of commercially operated nuclear power plants in the United States.

Naval nuclear power plants operate over lifetimes of up to five decades. Challenges to the reliability and integrity of the plants change and grow over this long life. Continuous monitoring and analyses are thus vital to ensure continued safe and reliable performance. Also, new knowledge gained during the years of operation must be assessed against the operating plants.

Since nuclear powered warships account for such a large portion of the Navy's combatant fleet, the successful operation of their reactor plants is a key factor in the Navy's ability to perform its national defense role. The safety record of the Naval Nuclear Propulsion Program is outstanding: nuclear-powered warships have steamed more than 128 million miles without a reactor accident or a significant release of radioactivity to the environment. The continued ability of the Navy to benefit from nuclear propulsion is dependent on continuance of this record.

The following are principal activity areas for this strategy:

- Design and test improved reactor equipment including advanced control rod drive mechanisms, which eliminate gears and provide rod speed flexibility.

- Perform physics testing and analysis to confirm expected fuel system and core performance; develop improved analysis methods for predicting core performance that reduce design approximations, uncertainties, and associated conservatism.

- Conduct reactor safety and shielding analyses to ensure containment of radiation and proper protection of personnel.

- Ensure satisfactory reactor plant operation throughout life, and improve steam generator, energy conversion and steam generator chemistry technologies to enhance performance and reduce maintenance costs.

- Develop instrumentation and control equipment to replace obsolete equipment and improve reliability and performance and reduce cost.

- Develop and test reactor plant components and applicable technologies, which address known limitations and improve performance and reliability of components.

- Perform reactor plant analyses to assure safe operation and improve reactor plant chemistry controls to reduce corrosion and plant radiation levels.

3. Accomplish planned core and reactor component/system design and technology development efforts to support the Navy's acoustic requirements.

One of the greatest advantages provided by submarines is stealth. Stealth—invisibility—allows submarines to operate undetected, conducting surveillance or performing offensive missions with minimal concern for defensive needs, providing, in effect, a tremendous force multiplier. This capability must be maintained in the face of ever improving means of detection. In order to do so, Naval Reactors must ensure the reactor components and systems used in submarines meet tightening Navy operating parameters for quieting.

Achieving stringent performance goals requires highly instrumented testing of components and the development of sophisticated analysis techniques to predict and measure hydrodynamics, structural dynamics, motor acoustics, fluid solid interactions, and sound transmission. These models are improving and being used in conjunction with testing of components. Advanced computational fluid dynamics models are being developed and will be used to improve the acoustic performance of future components.

The principal activity for this strategy is to develop and qualify improved core and reactor component thermal and hydraulic designs.

4. Maintain a utilization factor of at least 90 percent for operation of test reactor plants to ensure availability for planned tests of cores, components, systems, materials, operating procedures, and for scheduled training, and provide for development of servicing equipment to help ensure reactor safety and reliability.

Naval Reactors has two operating land-based prototype naval nuclear propulsion plants at the Kesselring site in New York, and also is the principal customer of the Advanced Test Reactor (ATR) located at the Idaho National Engineering and Environmental Laboratory.

The prototype plants are an essential component in meeting Naval Reactors' mission of ensuring the safe and reliable operation of naval reactor plants. Prototypes provide platforms for testing under actual operating conditions, which cannot be duplicated in the laboratory. This testing yields important technical data and experience, and allows potential problems to be identified and addressed before they occur in shipboard operating reactor plants. The prototypes are used to test new components and to verify reactor performance predictions by depleting the core faster than would be done in an operating shipboard plant. For example, the advanced fleet reactor, now used in the SEAWOLF class attack submarine, has achieved the equivalent of 26 years of shipboard operation in the S8G prototype plant. As a side benefit to the DOE, the prototypes are also used to train Navy nuclear plant operators. Training and qualification of nuclear operators remains a key part of the Program’s direct support of the operating Fleet; over 110,000 Navy nuclear power plant operators have been qualified in the Program’s rigorous training program. Utilization factor is a measure of prototype availability for planned testing, training, or maintenance. To maintain a high utilization factor, Naval Reactors must be forward thinking in identifying potential problems before they occur.

Operation of the ATR provides a unique capability to irradiate test specimens, which are then examined to provide data on the effects of radiation on materials. The ATR's arrangement permits varying conditions within the reactor test loops allowing accelerated life testing of materials, a major benefit.

At the end of core life, a servicing activity must remove the spent core from a reactor plant. This is an extremely critical operation given the radioactivity of spent fuel. If the reactor plant is to remain in service, a new core must be installed. Fuel handling equipment used in this operation is designed to operate safely under all possible normal and abnormal conditions, and thorough evaluations are conducted during the design and fabrication processes. Engineering models are tested to demonstrate proper operation and detailed procedures are prepared to cover use of the equipment.

The following are principal activity areas for this strategy:

- Operate the prototype plants to provide component and core depletion data and verification, plant integration experience, and to train reactor plant operators.

- Service land-based test reactor plants to ensure continued safe and efficient operation, and develop equipment and procedures to provide for safe and efficient servicing of nuclear reactor plants.

- Provide support funding to the ATR to provide for material irradiation testing.

5. **Safely and responsibly inactivate shutdown land-based reactor plants in support of Program and Departmental environmental cleanup goals.**

Naval Reactors has shut down six prototype reactor plants no longer required for testing or training. With the Windsor, Connecticut facility removed and land-transfer nearly complete, the three prototypes at NRF in an environmentally benign lay-up condition, and inactivation work continuing on the Kesselring Site prototypes, major prototype inactivation work is nearly finished.
The public expects and deserves prompt inactivation and remediation of shutdown reactor prototypes. Prompt dismantlement is also consistent with the Department's environmental clean-up goals, and is the most efficient and cost effective approach to this work.

The following are principal activity areas for this strategy:

- Continue efforts at the Windsor site in Connecticut to release applicable areas for unrestricted use.

- Continue inactivation and remediation efforts at the Kesselring Site in New York to eliminate surplus facilities, remediate and dismantle plant facilities and release applicable areas.

- Continue inactivation and remediation efforts at the Naval Reactors Facility in Idaho to eliminate surplus facilities, remediate and dismantle plant facilities and release applicable areas.

6. **Maintain outstanding environmental performance through radiological, environmental and safety monitoring, and continue cleanup of Program facilities.**

Naval Reactors continues to have an outstanding environmental performance record, despite today's stricter government regulations. Naval Reactors cleans up after itself in a rigorous, environmentally safe, and correct manner—including properly maintaining our facilities. The Program has established environmental compliance programs to meet all applicable regulations directed toward environmental excellence. This includes areas such as remediation of historical facilities, emphasis on recycling and waste minimization, strict standards for air and water emissions and monitoring programs to validate that Program activities have no adverse effect on the environment.

When properly and diligently dealt with, nuclear propulsion is a safe, efficient power source, and is environmentally less damaging than other sources. With regard to radiation, Naval Reactors has an aggressive program to minimize personnel exposure to as low as reasonably achievable such that since 1980 no Program personnel have received more than two REM in any one year.

The following are principal activity areas for this strategy:

- Conduct radiological control, environmental, and safety operations necessary to protect laboratory employees, minimize release of hazardous effluents to the environment, and comply with all applicable regulations.

- Conduct ongoing clean up of test facilities to reduce hazards to personnel, and reduce potential liabilities due to changing conditions or accidental releases.

- Conduct decontamination and decommissioning necessary to minimize the potential for future environmental chemical or radiological releases, minimize the costs of maintaining idle facilities, and free up central areas at various sites for future Program use.

Performance Measure Funding Matrix
FY 2005
Budget Categories
(dollars in thousands)

Performance Measures	Reactor Technology & Analysis	Plant Technology	Materials Development & Verification	Evaluation & Servicing
Meet Navy goals for extended warship operation, through:				
Nuclear heat source design and analysis methods	69,000			
Core manufacturing processes and inspection techniques	34,600			
Removed fuel cell and irradiated test specimen examination				48,090
Fuel, core and reactor structural material development & testing			52,800	
Plant materials development and testing			34,700	
Irradiations testing and examination			63,300	
Ensure safety and reliability of reactor plants, through:				
Reactor equipment design & testing	35,100			
Physics testing and analysis	21,000			
Safety and shielding analyses	13,700			
Steam generator, energy conversion, and chemistry technologies improvements		43,900		
Instrumentation and control equipment development		63,800		
Reactor plant components development & testing		38,100		
Reactor plant performance analyses and chemistry control		9,700		
Support Navy's acoustic requirements, through:				
Core and reactor component thermal and hydraulic design	16,000			
Ensure prototype plant availability, through:				
Operation of land-based test reactor plants				42,000
Servicing of land-based test reactor plants				16,400
Operation and servicing of the advanced test reactor				18,000
Inactivate shutdown prototype plants, through:				
Inactivation efforts in Connecticut				
Inactivation efforts in New York				15,200
Inactivation efforts in Idaho				400

Maintain outstanding environmental

	Reactor Technology & Analysis	Plant Technology	Materials Development & Verification	Evaluation & Servicing
Maintain outstanding environmental performance, through:				
Radiological, environmental and safety operations	42,700			
Cleanup of test facilities				31,910

Annually, the Office of Procurement and Assistance Management advises each of the Departmental elements of the annual assessment required to pay for the Defense Contract Audit Agency (DCAA) activities performed for the Department. The amount for Naval Reactors is $696,900 in FY 2004 and $730,400 in FY 2005.

Funding Schedule by Activity

(dollars in thousands)

Naval Reactors Development	FY 2003	FY 2004	FY 2005	$ Change	% Change
Plant Technology	108,897	130,625	155,500	+ 24,875	+ 19.0%
Reactor Technology & Analysis..	228,600	233,615	232,100	- 1,515	- 0.6%
Materials Development & Verification	135,969	136,888	150,800	+ 13,912	+ 10.2%
Evaluation and Servicing	151,975	169,693	172,000	+ 2,307	+ 1.4%
Facility Operations	41,486	48,015	50,811	+ 2,796	+ 5.8%
Total, Naval Reactors Development O&M	666,927	718,836	761,211	+ 42,375	+ 5.9%

Detailed Justification

Plant Technology	FY 2003	FY 2004	FY 2005

(dollars in thousands)

Mission Supporting Goals/Objectives:

Plant Technology focuses on developing, testing and analyzing components and systems which transfer, convert, store and measure power created by the nuclear reactor in a ship's power plant. Reactor plant performance, reliability, and safety are maintained via a thorough understanding of component performance and system condition throughout the life of a ship. Also, new components and systems are needed to support new reactor plants and to replace obsolete or degraded equipment and systems. Development and application of new analytical methods, predictive tests, and design tools are required to identify potential concerns before they become actual problems. This enables preemptive actions to ensure continued safe operation of reactor plants. Advances in modeling, analysis, and water chemistry are already permitting the safe operation of components beyond their original design life. Continued progress in various technologies such as manufacturing/welding processes, fluid dynamics, predictive models/analysis and thermal-hydraulics are enhancing operating plant performance and allowing major improvements in performance for new reactor plants. For example, the reactor plant systems and components now under development for the VIRGINIA- and CVN 21-class will be more dependable, improve operating efficiency, and reduce life cycle costs.

Reactor plants require constant monitoring and analysis due to exposure to extreme temperatures and pressures. Steam generators are especially susceptible to corrosion due to the intense boiling environment required to convert reactor heat to steam. Naval Reactors is pursuing technologies to greatly reduce corrosion through fundamental design changes in components and water chemistry.

Wear and tear on operating reactor machinery, such as pumps with constantly rotating parts, limit system and component life and can require extensive and costly maintenance. Plant Technology provides funding for programs to combat wear and tear through the implementation of better materials and lubricants, as well as more resilient designs, creating longer-lived and more reliable components and systems with reduced maintenance requirements. In addition, these programs provide for the comprehensive testing and review required to ensure improvements for one area of the plant do not cause unanticipated problems in another area of the plant.

Extensive development work is devoted to applying advances in electronics to instrumentation and control equipment and systems. Due to the harsh and intense operating environment and rapid obsolescence of electronic equipment, this equipment must be replaced during the lifetime of an operating plant. While this presents a continuing challenge, rapid technical advances are providing distinct advantages. For example, improved accuracy and reliability of the new design instrumentation extend the long-term useable power obtained from the reactor. Also, developing human-machine interface and data collection schemes allow for a less expensive incorporation of new display technologies while presenting data to the operator in a more effective manner.

Plant Technology	FY 2003	FY 2004	FY 2005
	(dollars in thousands)		

I. Complete scheduled design, analysis, and testing of reactor plant components, systems, and performance to ensure the operational safety and reliability of reactor plants for use in Naval nuclear powered warships so they can fulfill their national defense mission.

	FY 2003	FY 2004	FY 2005
A. Improve nuclear reactor core design and analysis methods and develop improved designs to satisfy service life requirements.......	**20,497**	**31,800**	**43,900**

Steam generators provide energy to the main turbines by converting heat from the reactor plant into a usable medium — steam. To accomplish this, extremely hot pressurized water from the reactor primary system flows through multiple thin-walled tubes necessary to efficiently transfer the reactor heat in the heat exchanger within the steam generator. A shell containing secondary water surrounds these tubes. The secondary water is at a lower pressure and boils into steam. Consequently, integrity of steam generator pressure boundary parts and tubing is crucial to prevent leaks and radioactive contamination of the steam leaving the steam generator to power the turbines.

Maintaining steam generator integrity over the full service life, especially as we extend the service life of ships, requires improving understanding of high temperature corrosion processes, assessment of potential causes and corrective actions, and development of alternative water chemistries which can inhibit or abate corrosion. Trace impurities become highly concentrated by the boiling process in areas of low flow, and form deposits. The concentration of impurities in these deposits can become corrosive and threaten the integrity of the unit. Development work focuses on evaluating corrosion mechanisms, devising methods to locate and remove deposits, minimizing input of impurities, and evaluating and testing water chemistries and corrosion inhibitors for benefits and drawbacks to ensure they mitigate the consequences of impurities over the life of the plant.

By utilizing advanced energy conversion devices, significant gains may be made to the power conversion generator and propulsion plant efficiencies which could potentially enable quieter, simpler, and more cost-effective Naval propulsion plants. This will support future Naval Nuclear propulsion feasibility assessments. Development work is underway for steam generator improvements to meet energy and power requirements for the Transformational Technology Core (TTC).

CVN 21 shipbuilding schedules and goals for reduced weight, manning, and life cycle costs, require development of an improved steam generator. Development work centers on new tubing materials, new corrosion controls, improved heat transfer methods, and steam separation predictive tools are used to meet goals of cost and weight reduction while enhancing performance.

(dollars in thousands)		
FY 2003	FY 2004	FY 2005

Verifiable Supporting Activities:

FY 2003 Conduct steam generator thermal and hydraulic testing to support analysis tool qualification and reduced inspection frequency and cost for steam generators.

Continue to monitor and evaluate LOS ANGELES- and OHIO-class steam generators to reduce cost and frequency of inspections and cleaning.

Continue to design and build improved in-plant chemistry and electrochemistry monitoring capabilities to identify and reduce steam generator corrosion issues.

Continue development of advanced energy conversion systems incorporating state of the art technology and engineered improvements. Evaluate application feasibility of alternative energy conversion systems.

FY 2004 Pursue steam generator improvements and alternate designs required to meet the energy and power demands for TTC.

Perform additional evaluations and testing of emergent alternate energy conversion concepts and demonstrate larger scale advanced energy conversion systems achieving high energy conversion efficiency to support future cores.

Complete steam generator thermal and hydraulic testing to support analysis tool qualification and reduced inspection frequency and cost for steam generators.

Continue to monitor and evaluate LOS ANGELES- and OHIO-class steam generators through the use of corrosion testing to reduce cost and frequency of inspections and cleaning, as well as prolong steam generator service life.

Continue to implement use of in-plant corrosion monitors in prototype steam generators to provide data-defining actual conditions in operating steam generators.

FY 2005 Develop larger scale integrated thermophotovoltaic system with high energy conversion efficiency and power density.

Evaluate use of alternate chemistry treatments and proceed with qualification for use in applicable LOS ANGELES-class submarines to assure corrosion limits for the life of the ship are not exceeded.

Complete work to provide a down select recommendation for the steam generator design with longer life and higher power rating supporting TTC.

Plant Technology	(dollars in thousands) FY 2003	FY 2004	FY 2005

Continue to monitor and evaluate LOS ANGELES- and OHIO-class steam generators through the use of corrosion testing to reduce the cost and frequency of inspections and cleaning, as well as prolong steam generator service life.

Continue to implement use of in-plant corrosion monitors in prototype steam generators and other components to provide data-defining actual conditions in operating steam generators for potential fleet application.

	FY 2003	FY 2004	FY 2005
B. Develop instrumentation and control equipment to replace obsolete equipment and improve reliability and performance	**44,880**	**50,800**	**63,800**

Naval reactor plant operators rely on instrumentation to monitor plant conditions, take corrective action, and determine position and speed of the control rods used to regulate reactor output. Safe and reliable operation of the plant is dependent on the reliability and performance of this equipment. Improved performance characteristics of instrumentation and control equipment is key to improving reactor performance and extending reactor core life. The development of highly reliable and efficient advanced electrical conversion equipment can increase actual usable power available from the reactor.

The Naval Reactors program has taken advantage of advancements in microprocessor-based instrumentation and control (I&C) equipment to increase instrumentation accuracy and to improve reactor operations. In the past, unique I&C equipment was designed for each class of ships. In some cases, ships in the same class have different equipment. Development of special purpose instrumentation and control equipment for single applications is costly and creates logistics problems in maintaining an inventory of spare parts for many different systems. It also requires additional training for operators. Therefore, it is necessary to develop "generic" I&C equipment that uses commercially available technology (modified for military use) that can be backfit into existing designs, is easy to upgrade as technology evolves, and can be used in all fleet applications with only minor modifications for ship specific needs. Generic I&C equipment, which establishes common system architecture for all plants, will reduce costs of acquisition, maintenance and logistics, and will allow development of specific applications to new plants in about one-half the time of the current 10-year cycle.

Verifiable Supporting Activities:

FY 2003 Conduct design, testing, and qualification of power conversion technology and selected solid state motor drives with advanced control techniques for proof-of-concept testing.

Begin detailed design of a CVN 21 reactor plant instrumentation system and issue CVN 21 functional requirements.

Complete LOS ANGELES-class generic I&C production equipment fabrication and NIMITZ-class production equipment design and fabrication.

(dollars in thousands)

Plant Technology	FY 2003	FY 2004	FY 2005

FY 2004 Install improved generic I&C equipment in LOS ANGELES-class ships and complete composite test facility procedure checkout and crew familiarization.

Design, develop and qualify field changes to address emergent needs for I&C equipment changes and parts obsolescence in order to improve reliability of existing hardware in operating plants.

Commence development of OHIO-class system laboratory models. Complete OHIO-class functional requirements and conduct further development of system laboratory models.

Continue design, testing, and qualification of power conversion technology and solid state motor drives with advanced control techniques to improve efficiency, maintenance, and performance.

Continue detailed design of a CVN 21 reactor plant instrumentation system with state-of-the-art equipment capabilities compatible with a vendor base.

FY 2005 Initiate design concepts for a replacement solid state or vacuum circuit breaker technology to provide circuit breakers with no moving parts to improve reliability.

Develop modifications to I&C systems to support TTC goals for an extended core life.

Develop selected motor drive technology incorporating advanced control techniques while meeting the unique shipboard applications of the VIRGINIA-class.

Initiate OHIO-class generic instrumentation and control preproduction equipment fabrication. Start evaluation testing to identify potential problems before design finalization and minimize development costs

Continue detailed design of a CVN 21 reactor plant instrumentation system with state-of-the-art equipment that will have a common system architecture for all reactor plant types of its class.

Plant Technology	(dollars in thousands) FY 2003	FY 2004	FY 2005
C. Develop and test reactor plant components and applicable enabling technologies which address known limitations and improve overall reactor plant systems performance and reliability……..………………………………..	**34,097**	**38,325**	**38,100**

Naval Reactors evaluates current technologies and applies them to develop simpler components that maximize plant efficiency, reliability and safety. For example, the main coolant pump used in the NIMITZ-class carrier reactor plant, originally designed in the early 1960's, is being redesigned for placement on CVN 77 to incorporate current technologies addressing problems related to wear, improving performance and reliability over the pump's operating life.

Studies are also underway to design, develop, and test enabling technologies that will improve the military characteristics and affordability of future Naval nuclear propulsion plants without compromising safety or performance. Specific reactor plant system and component design work is ongoing for application to VIRGINIA-class submarines and the next-generation aircraft carrier, CVN 21, which will provide improved capability and a simplified, more affordable propulsion plant. Simplifying the reactor plant will not reduce the reliability of the plant. Improvements will provide for a greater ease of operation and more power available for other uses throughout the ship.

Additionally, improvements to reactor plant components are needed for the development of the Transformational Technology Core which could extend ship life by at least 30% and increase power output in VIRGINIA-class ships.

An important consideration in each redesign is fluid flow through each component and system in the reactor plant because pressure changes in each component have an effect on flow through the core. Deviations from nominal flow can cause a heat level imbalance within the core; therefore, strict tolerances are essential for safe and efficient operation of the entire plant. Each component design is flow tested to ensure it operates within the intended design range and that it will operate reliably over extended periods of operation.

Verifiable Supporting Activities:

FY 2003 Continue to resolve reactor plant systems and component design issues in support of VIRGINIA plant construction.

Continue design of CVN 21 reactor plant fluid systems and complete development of design details. Begin development of the CVN 21 reactor plant operating procedures.

Continue design of the CVN 21 main coolant pump and continue manufacture of the prototype CVN 21 Reactor Coolant Pump.

Plant Technology	(dollars in thousands)		
	FY 2003	FY 2004	FY 2005

Continue design of the CVN 21 steam generator and pressurizer. Prepare detailed ordering requirements for fabrication.

FY 2004 Perform development work on improvements to plant components (e.g. pressurizer, reactor coolant pump) to enable performance enhancements commensurate with the anticipated performance of the Transformational Technology Core.

Finalize resolution of reactor plant design issues in support of VIRGINIA construction to have an arrangement which incorporates innovative construction techniques and which is technically sound and economical to build.

Complete design of the CVN 21 main coolant pump so that it incorporates the latest technologies and is affordable. Complete the manufacture of the prototype CVN 21 Reactor Coolant Pump and initiate engineering qualification testing

Complete design of the CVN 21 steam generator and pressurizer incorporating the latest technologies while remaining affordable. Initiate shipset fabrication.

Continue design of CVN 21 reactor plant fluid systems and continue development of the CVN 21 reactor plant operating procedures in order to develop a primary propulsion plant that is less costly to build, operate, and maintain.

FY 2005 Initiate design activities necessary to increase VIRGINIA plant life and power capability to correspond with TTC insertion.

Evaluate, develop, and test new features and materials in various VIRGINIA reactor coolant pump components to improve motor and hydraulic efficiency.

Continue design of CVN 21 reactor plant fluid systems and continue development of the CVN 21 reactor plant operating procedures in order to develop a primary propulsion plant that is less costly to build, operate, and maintain.

Continue engineering qualification testing of the CVN 21 reactor coolant pump.

Continue design of the CVN 21 reactor plant to provide a more affordable reactor plant requiring less maintenance, less manning, and can be built using modular construction techniques.

Plant Technology	(dollars in thousands) FY 2003	FY 2004	FY 2005
D. Perform reactor plant analyses to ensure safe operation and improve reactor plant chemistry controls to reduce corrosion and plant radiation levels………………………………..	**9,423**	**9,700**	**9,700**

Under pressure, the reactor core heats primary system water that flows through the steam generator. The steam generator absorbs the transferred heat in the secondary water system, producing steam to power the turbines. Any corrosion products present in the primary reactor water cycle will be carried through the plant and irradiated in the core. Build-up of corrosion products in the core acts as insulation and narrows the water channels, reducing flow and heat transfer.

Proper chemistry control and constant water purification is crucial to reducing corrosion. Development work focuses on improving primary side chemistry and surface conditioning technology to reduce corrosion and permit improved design and the reduction of radiation levels. A constant flow of data from test facilities and operating plants plays a key role in the development process.

Detailed reactor system performance analyses are also performed to ensure Naval reactor plants are safe during normal, transient and casualty conditions. The advanced integrated reactor plant protection systems that provide automatic reactor shutdown when the operating limits established by the performance analyses are exceeded ensure the plant will operate safely and reliably during all phases of operation. Requirements in the area of protection analysis are constantly evolving due to extended plant design life and increased plant capabilities. Improvements to analysis codes are needed to achieve compliance with these evolving demands. As new test data becomes available, comparisons with analysis predictions are made and identify the need for improvements in predictive capability. State of the art analysis techniques are under development to meet these dynamic needs.

Through continuous improvement in chemistry, reactor protection system analyses, and advances in metallurgy discussed in the Materials Development and Verification category, Naval Reactors has consistently maintained radiation levels well below regulatory requirements and maintained an enviable record of safeguarding the environment, health of the crew, and servicing personnel. These advances have also provided enhanced reliability and a reduction of maintenance costs.

Verifiable Supporting Activities:

FY 2003 Qualify use of advanced reactor coolant chemistry analysis methods in OHIO- and NIMITZ-class ships to improve the quality of data and reduce operator training requirements.

Continue to monitor results of special treatment in reducing radiation levels in LOS ANGELES-class ships.

Continue to evaluate open items and emergent issues to support the VIRGINIA-class reactor systems performance analysis.

Plant Technology	FY 2003	FY 2004	FY 2005

(dollars in thousands)

Continue to perform the necessary reactor protection analyses for the CVN 21 final core design.

FY 2004 Evaluate initial test problem issues and results for impact on VIRGINIA-class reactor systems performance analysis.

Continue to monitor results of special treatment in reducing radiation levels and associated personnel exposure during maintenance evolutions in LOS ANGELES-class ships.

Implement use of advanced reactor coolant chemistry analysis methods in OHIO- and NIMITZ-class ships to improve the quality of data and reduce operator training requirements.

Continue to perform reactor protection analysis to support development of the CVN 21 Primary Nuclear and Core Protection Instruments in order to optimize the operational flexibility of CVN 21 and ensure the safe operation of the reactor.

FY 2005 Support development of automated primary chemistry equipment for CVN 77 construction and fleet application including CVN 21 in order to reduce crew time for chemistry control and analysis, thereby reducing crew radiation exposure.

Continue to evaluate results from special treatment demonstrations in LOS ANGELES-class ships to facilitate reduced radiation levels and associated personnel exposure during maintenance evolutions.

Continue use of advanced reactor coolant chemistry analysis methods in OHIO- and NIMITZ-class ships to improve the quality of data and reduce operator training requirements.

Continue to perform reactor protection analysis to support development of the CVN 21 reactor plant design prior to the initial operation of the plant in order to optimize the operational flexibility of CVN 21 and ensures the safe operation of the reactor.

Total, Plant Technology	**108,897**	**130,625**	**155,500**

Detailed Justification

Reactor Technology and Analysis	(dollars in thousands)		
	FY 2003	FY 2004	FY 2005

Mission Supporting Goals/Objectives:

Reactor Technology and Analysis supports the work required to ensure safety and reliability of operating reactor plants in U.S. warships, extend the operational life of Navy nuclear propulsion plants, support Navy acoustic requirements, and preserve the Program's level of excellence in radiological and environmental control. Work focuses on developing a greater fundamental understanding of reactor behavior; designing new, longer lived reactors with improved reliability, efficiency, and greater energy density; improving and streamlining manufacturing and assembly processes to achieve cost savings and reduce waste; developing production techniques that incorporate new materials and processes; and continuing a record of excellence in safety.

Development of reactor design and analytical techniques provides a more accurate forecast of reactor performance, thereby yielding next generation designs of a more advanced nature. Likewise, work is underway to improve analysis tools to better understand performance over longer core and reactor lifetimes, which will reduce overall cost.

Development and qualification of core and reactor component thermal/hydraulic designs will further optimize reactor power while reducing coolant flow, thus facilitating improved acoustic performance. To accomplish this, emphasis is on thermal/hydraulics, structural/fluid mechanics, vibration analyses, and nuclear core design/analysis work. In addition, improved core manufacturing processes and inspection techniques also are being pursued to improve efficiency and support extended life requirements.

Other initiatives are dedicated to designing and testing simpler, more reliable reactor equipment, and developing improved shield designs that reduce cost and minimize weight without increasing personnel radiation exposure. Radiological and environmental monitoring and controls ensure operations are conducted without adverse impact on employees or the environment.

Reactor Technology and Analysis	(dollars in thousands) FY 2003	FY 2004	FY 2005

I. Conduct planned development, testing, examination, and evaluation of nuclear fuel systems, materials, and manufacturing and inspection methods to ensure naval nuclear reactors are able to meet Navy goals for extended warship operation.

	FY 2003	FY 2004	FY 2005
A. Improve nuclear reactor core design and analysis methods and develop improved designs to satisfy service life requirements.	**63,800**	**66,115**	**69,000**

The demand for extended service life and for increased operational flexibility necessitates achieving a better understanding of the reactor core environment. As testing provides more comprehensive data, new analytical models can be qualified, which establish new, or revise existing core performance criteria. Reactor operating guidelines are developed according to these new or revised criteria.

Engineering analyses and testing in the areas of nuclear analysis, thermal-hydraulics, structural mechanics, fluid mechanics, dynamic structural load tests, and shock and vibration are needed to show the acceptability and performance of the core and reactor component designs.

New designs such as the next generation reactor (NGR) for VIRGINIA-class submarines, high energy reactor (HER) being developed for the new CVN 21-class aircraft carriers, and Transformational Technology Core (TTC) and less restrictive operating limits derived from improved design codes will enable new reactors to meet service life and performance requirements. The NGR core for the VIRGINIA-class is the first designed from inception to last the life of the ship. The core for CVN 21 will provide greater than 25 percent more energy than the NIMITZ-class cores. TTC will use advanced reactor core materials to gain a significant energy increase without increasing size or weight, and follows NGR as a life-of-the-ship core.

Development work for new core designs entails using independent models and analysis techniques to calculate and validate the structural and thermal-hydraulic design of the new core. The long-term goal of this work is to develop and fully qualify fundamental two-phase, three-dimensional thermal-hydraulic and structural models to accurately predict core performance under all operating and casualty conditions, and to do so using fewer approximations resulting in reduced uncertainties and associated costly conservatism in advanced reactor design. Key reactor plant components and design features are tested under prototypic operating conditions to demonstrate the mechanical, thermal-hydraulic, and flow-induced vibration acceptability of the design and manufacturing processes.

Verifiable Supporting Activities:

FY 2003 Design and initiate performance-mapping tests for advanced energy conversion test arrays to aid in the development of high efficiency direct heat-to-electricity energy conversion devices.

Develop improved parallel processing capabilities for computationally intensive structural analyses to enable enhanced review capability to optimize reactor design.

Complete core mechanical design and analysis and issue drawings to support initiation of A1B core manufacturing.

Continue A1B reactor hydraulic and mechanical design qualification tests and procure equipment for flow and shock/ vibration test programs for A1B fuel cell to validate the design and improve hydraulic and structural design methods.

Continue preparations for the VIRGINIA critical test program.

FY 2004 Initiate A1B hydraulic, flow-induced vibration and shock test programs for the A1B fuel cell that validate the design and improve hydraulic and structural design methods.

Pursue integration of core performance analysis codes to be applied to development of the TTC.

Perform thermal-hydraulic analysis evaluations to extend high power capability to longer lifetimes and higher power gradients demanded by TTC.

Integrate advanced energy conversion test arrays into system concepts and tests to demonstrate improved system efficiency.

Initiate development of an A1B core design utilizing lower enriched fuel for use in CVN 21 follow ship.

Update thermal-hydraulic engineering processes to improve design and analysis work efficiency and continue long-term operation support.

Complete the VIRGINIA critical test program.

Continue to develop improved parallel processing capabilities for computationally intensive structural analyses and implement methodology to remove excess conservatism from fracture analysis procedures.

FY 2005 Complete design analyses on A1B to support core certification. Additionally, provide structural and thermal-hydraulic analyses and assessments to resolve unforeseen manufacturing developments encountered with A1B core production.

Complete TTC core conceptual design and initiate final design and development work.

Continue A1B hydraulic and mechanical fuel cell testing to validate the design.

Complete development of an A1B core design utilizing lower enriched fuel for use in the CVN 21 follow ship.

Perform a comprehensive review of NR Program service experience to validate/calibrate fatigue crack growth procedures and total fatigue life. Pursue development of advanced material models appropriate for cyclic elastic-plastic finite element analysis to produce more efficient structural designs for reactor plant components.

Provide conceptual studies of reactor designs using high temperature fuel systems that can provide increased energy density in an advanced pressurized water reactor (PWR) application.

	FY 2003	FY 2004	FY 2005
B. Evaluate and test improved fuel and core-manufacturing processes and inspection techniques to support extended life of reactors	**28,800**	**39,000**	**34,600**

Desirable new core design features and the drive for cost savings necessitate manufacturing process improvements. These improvements are dependent on technological advancements. Fuel and core manufacturing limitations in previously designed naval reactor cores require compensatory margins in core designs and operating limits that constrain power density and life expectancy. Modifying the fuel and core manufacturing process allows cores to operate longer and with greater power output capability. In addition, the modified manufacturing process will minimize waste. This process is technically challenging, but necessary to improve the fuel to produce more energy-dense cores, such as TTC, at a lower cost for new core designs.

Verifiable Supporting Activities:

FY 2003 Construct additional model elements and core structural components with new reactor manufacturing techniques to reduce fuel costs and verify new inspection technologies to improve inspection efficiency and reduce reliance on destructive tests.

Complete fuel element process qualifications to support starting A1B core manufacturing.

Continue fabrication of prototypes to refine the fuel systems and assembly process required for CVN 21 prior to committing resources to large-scale production.

Initiate production efforts associated with the lead A1B core and identify new technologies to improve baseline processes.

FY 2004 Continue production efforts associated with the lead A1B core and identify new technologies to improve baseline processes.

Conduct manufacturing development for TTC utilizing advanced clad and fuel materials.

Conduct extensive fuel, fuel element, and fuel assembly development work to determine whether to commit to a full-scale demonstration core in a VIRGINIA-class ship.

Continue to construct additional model elements and core structural components with new reactor manufacturing techniques to reduce fuel costs and evaluate new inspection technologies to improve inspection efficiency and reduce reliance on destructive tests.

FY 2005 Evaluate results of initial A1B core production efforts and identify changes to be evaluated to improve the baseline processes.

Evaluate core vendor test procedures for discriminating between 93% and 97% enriched fuel and qualify low-enriched fuel for S9G fuel element use.

Conduct TTC manufacturing development utilizing advanced clad and fuel materials to support qualification efforts for use in the first VIRGINIA-class low-enrichment core.

Continue fabrication of model elements and core structural components to qualify new reactor materials, designs, and manufacturing and inspection technologies for future core technologies.

II. Complete scheduled design, analysis, and testing of reactor plant components, systems, and performance to ensure the operational safety and reliability of reactor plants for use in Navy nuclear powered warships so they can fulfill their national defense mission.

	FY 2003	FY 2004	FY 2005
A. Design and test improved reactor equipment, including advanced control drive mechanisms	**42,000**	**35,100**	**35,100**

Reactor safety/reliability demands that the mechanisms that drive control rods to moderate the reactivity of the reactor perform without incident. The NGR control drive mechanism is the first fundamentally new mechanism to be designed in 25 years. With the design in the final stages of qualification, remaining testing focuses on providing consistent rod control and protection against potential casualties for the entire life of the ship. For the A1B reactor plant, a new scaled-up control drive mechanism is required. The sheer size of the control rod presents engineering challenges for mechanism design. One challenge is the design and development of bearings required to operate for sixty years. Not only must the new control drive mechanism be developed to handle an unprecedented load, but it is also constrained by plant-wide limitations on space and mechanism operating power. Additionally, a more accurate control rod position indicator is being developed to meet increased plant control and safety goals. In addition to increased reliability, these new designs should prove to be simpler and less expensive than past designs.

Naval Reactors also must develop and qualify reactor heavy equipment, including reactor vessels, closure heads, closure studs, and core baskets to accommodate new core designs. Work is focused on extending technologies developed for NGR equipment to the design of the CVN 21 reactor equipment and supporting longer carrier service lives. As part of this effort, three-dimensional structural analysis tools will be developed and applied.

Verifiable Supporting Activities:

FY 2003 Complete final design of the A1B control drive mechanism (CDM) and fabrication of the CDM Lead units for prototypical tests that demonstrate that they function as intended.

Complete final engineering certification of the reactor vessel and closure head that shows on paper that all design requirements have been met.

Continue A1B reactor heavy equipment structural analyses and design reviews and complete closure head and core basket final design.

Continue design of the reactor head area to include tolerance, alignment studies, structural analyses, and design compliance checklists to ensure trouble-free assembly at the shipyard and successful operation for the life of the ship.

FY 2004 Conduct life and shock and vibration tests on the A1B CDM Lead Units and resolve design issues experienced during CDM prototype fabrication.

Initiate limited development of control rod drive mechanisms bearing lifetime to support extended TTC lifetime.

Continue detailed A1B reactor engineering analyses and design reviews and complete closure head and core basket final engineering certification.

Continue detailed design of the reactor head area to include tolerance, alignment studies, structural analyses, and design compliance checklists to ensure trouble-free assembly at the shipyard and successful operation for the life of the ship.

FY 2005 Complete engineering certification for the A1B CDM and A1B reactor heavy equipment.

Conduct shock testing of the A1B casualty monitoring instrumentation and head area arrangement (HAA) components.

Initiate thermal/structural analyses for TTC pressure vessel.

Continue development of control rod drive mechanism bearing lifetime to support extended TTC lifetime.

	FY 2003	FY 2004	FY 2005
B. Perform physics testing and analysis to confirm expected fuel system and core performance and develop improved analysis methods for predicting core performance that reduce design approximations, uncertainties, and associated conservatism..............................	**21,100**	**21,000**	**21,000**

The first cores Naval Reactors developed had expected service lives of two years. Subsequent research and development resulted in core service lives of over twenty years, and current design work will deliver a life-of-the-ship core that will last over thirty years.

While yielding significant advantages in terms of reduced radiation exposure, reduced cost, and increased ship availability, the longer core life is pushing nuclear analysis tools beyond proven experience. These tools are limited in their ability to accurately predict core physics performance in later phases of core-life. Consequently, Naval Reactors is developing improved methods and tools to continue safe and reliable operation at stages in life which extend well beyond current operating experience.

Physics models use approximations that limit design precision and require allowances to be built into the design. Naval Reactors is developing, and has begun using, advanced, more precise nuclear design methods and software that reduce uncertainties and associated costly conservatism in advanced reactor design. The reduction in uncertainty and bias applied to core reactivity predictions is accomplished by resolving more accurate predictions of power levels in the various regions of a core under transient and steady state conditions. This resolution leads to reduced costs and improved reactor performance and enables attainment of higher performance, more cost-effective, and safe nuclear designs.

Qualification of these improved analytical and design methods require extensive testing, comparison of calculations to experimental results and operating experience, and validation of predictions against prototype core measurements. Likewise, differences between calculations and experimental results must be resolved and the results factored into improved methods and computer programs.

Reactor Technology and Analysis	(dollars in thousands) FY 2003	FY 2004	FY 2005

Improved basic nuclear data, such as neutron cross-sections, are needed to improve performance of existing cores and optimize new core designs. Naval Reactors is working to identify and perform experimental programs that would lead to improvements in this area.

Verifiable Supporting Activities:

FY 2003 Initiate physics analyses needed to establish detailed CVN 21 operating limits and control system characteristics.

Measure and test new cross-section data derived from linear accelerator experiments to improve accuracy of nuclear design calculations.

Improve accuracy of core burn-up predictions by applying improved physics methods, modeling procedures and cross section data.

Continue to evaluate physics data from late-in-life operation of the advanced fleet reactor prototype core to validate performance predictions for S6W.

FY 2004 Implement advanced solution strategies to improve reactor physics computation efficiency for supercomputers and distributed computing environment.

Develop physics data required to support the conceptual design phase for TTC.

Continue physics analyses needed to establish detailed CVN 21 operating limits and control system characteristics.

Continue to measure and test new cross-section data derived from linear accelerator experiments to reduce uncertainties in nuclear design calculations for emergent core concepts.

Continue to evaluate physics data from operation of prototype cores to validate performance predictions for fleet cores.

FY 2005 Develop physics data required to support the reference design phase for TTC.

Evaluate physics data from VIRGINIA-class initial criticality and physics acceptance tests.

Perform nuclear design and analysis to develop TTC core design and to support initial manufacturing development.

Perform reference design analyses for the NGR core to accept the use of low-enriched (93%) fuel.

	(dollars in thousands)		
	FY 2003	FY 2004	FY 2005
C. Conduct reactor safety and shielding analyses for nuclear reactor plants to ensure containment of radiation and proper protection of personnel	**13,800**	**13,700**	**13,700**

Continue to evaluate physics data from operation of prototype cores to validate performance predictions for fleet cores.

Continue to measure and test new cross-section data derived from linear accelerator experiments to reduce uncertainties in nuclear design calculations for emergent core concepts.

Naval Reactors conducts reactor safety analyses of all plants and new core designs to ensure that their operation poses no threat to operators or the public. Safety assessments are conducted for specific reactor plant designs to identify any potential safety vulnerabilities and assess the likelihood of a core-damaging casualty. Additionally, commercial nuclear power activities are monitored for applicability to NR plants.

Shielding analyses are also conducted to ensure effective attenuation of radiation and continued safe operation. Alternative shield and plant materials and fabrication methods are sought to improve shield effectiveness, while improving reactor plant affordability, reducing weight, and eliminating the use of hazardous materials such as lead. Shielding analysis method improvements permit a more accurate prediction of radiation shielding effectiveness, as well as the extent of radiation received by personnel, reactor components, and materials. As a result, shielding is better optimized to reduce radiation exposure to personnel and equipment during reactor plant servicing and operation and during the handling and shipment of spent nuclear fuel and other highly radioactive materials. Naval Reactors is working to reduce the weight and resultant cost of installed shielding without impacting radiation exposure to personnel.

Verifiable Supporting Activities:

FY 2003 Determine the scope of thermal/hydraulic tests necessary to support A1B reactor safety modeling and analysis.

Evaluate improvements to neutron and gamma transport codes to support advanced shield designs that reduce shield weight and cost.

Complete the NRC/ACRS review of the next generation reactor and provide technical support as necessary.

Complete radiation analyses for final design of A1B reactor plant equipment.

FY 2004 Develop new shield materials for advanced plant design and develop and install new shield design software.

Implement improvements to neutron and gamma transport codes to support advanced shield designs and the more stringent TTC energy density in a cost-effective manner.

Perform penetration shield design studies and support validation of the shipyard CVN 21 penetration shield analysis.

Initiate detailed design of hardware to perform technical/hydraulic tests necessary to support A1B reactor safety modeling and analysis.

Initiate containment test program in support of A1B reactor plant safety analyses.

FY 2005 Complete the A1B penetration shield design. Additionally, evaluate alternate bulkhead configurations for weight and cost reductions via utilization of advanced materials.

Perform safety analyses for the A1B Safety Analysis Report and develop uncertainty methodology for A1B Best-Estimate Loss-Of-Coolant-Casualty analysis.

Continue design studies and validation of the shipyard A1B penetration shield analysis.

Evaluate shielding impact of propulsion plant design changes for CVN 21 follow-ship.

Initiate procurement of hardware for thermal/hydraulic tests to support A1B reactor safety modeling and analysis.

III. Accomplish planned core and reactor component/system design and technology development efforts to support the Navy's acoustic requirements.

	FY 2003	FY 2004	FY 2005
A. Develop and qualify improved core and reactor component thermal and hydraulic designs	**16,100**	**16,000**	**16,000**

The acoustic signature of a reactor is driven principally by the flow of water through the core. Reductions in the flow, and corresponding improvements in acoustic performance, are limited by the necessity to safely maintain reactor power, which requires a flow of water through the core to dissipate heat. Naval Reactors continues to improve core performance and quieting with advancements in thermal and hydraulic design which enable greater power per unit flow, allowing flow to be reduced while safely maintaining power.

(dollars in thousands)

Reactor Technology and Analysis	FY 2003	FY 2004	FY 2005

Work in this area focuses on developing more advanced calculation methods and software used in thermal-hydraulic analytical models and codes. These improved tools will enable a more realistic approximation of flow requirements. This work is helping to deliver more balanced reactor designs with reduced reliance on expensive tests in reactor design.

Verifiable Supporting Activities:

FY 2003 Extend thermal-hydraulic analysis methodology to apply advanced codes to transient thermal-hydraulic analyses to reduce reliance on complex and expensive transient tests.

Update and complete additional testing of advanced code analysis that solves basic physical equations for flow and heat transfer.

Initiate development of advanced Computational Fluid Dynamics tools for prediction of broad band noise while continuing testing for development of thermal criteria.

FY 2004 Extend thermal-hydraulic analysis methodology to apply advanced codes to flow oscillation thermal-hydraulic analyses of A1B that are needed to enable a simplified, lower cost plant concept.

Develop additional advanced thermal-hydraulic analysis tools to reduce reliance on expensive testing

Perform testing to assess capability of Computational Fluid Dynamics tools for prediction of broad band noise.

FY 2005 Initiate work to extend advanced code and methodology to evaluate multi-channel analysis capability to improve core and component acoustic performance and core thermal performance.

Apply Computational Fluid Dynamics tools to predict advanced reactor design test data and to predict fundamental broad band noise data.

Evaluate flow oscillation and transient data to support A1B design basis.

Reactor Technology and Analysis	(dollars in thousands) FY 2003	FY 2004	FY 2005

IV. Ensure no personnel exceed Federal limits for radiation exposure and no significant findings result from environmental inspections by state and federal regulators.

A. Conduct radiological control, environmental, and safety operations necessary to protect laboratory employees, minimize release of hazardous effluents to the environment, and comply with all applicable regulations	**43,000**	**42,700**	**42,700**

Proper control of radiological materials is paramount to the health and safety of workers, the public, and the environment. Naval Reactors enforces strict compliance with requirements for the management and disposal of radioactive, hazardous, and mixed waste. Additional procedures are in place to ensure full compliance with evolving environmental, health, and safety requirements. The principal focus of this environmental work is to prevent the creation of environmental hazards by minimizing wastes and preventing pollution. Areas where historical operations were conducted are evaluated to assess environmental impacts and determine the extent of remedial actions. Training is conducted to ensure radiological safety and environmental requirements are understood. Audits are routinely conducted to assess the adequacy of facilities and equipment, employee training, and effective enforcement of existing controls. Emergency response capabilities are in place to control or mitigate any problems, while personnel and affected work areas receive routine radiological monitoring to ensure exposure is within minimal limits. Environmental, safety, and industrial hygiene monitoring is performed to confirm operations do not impact Program sites or the surrounding communities.

Verifiable Supporting Activities:

All Years Survey and document radiological conditions; train personnel for all phases of radiological work and environmental work.

Maintain strict accountability methods and fuel handling for nuclear fuel.

Ensure compliance with all safety and environmental regulations; train personnel to comply with latest standards and practices.

Minimize the production and safely dispose of all waste in accordance with applicable regulations.

Characterize historical operations areas and determine appropriate remedial actions.

Audit compliance to all regulations to ensure effectiveness of controls.

Total, Reactor Technology and Analysis	**228,600**	**233,615**	**232,100**

Detailed Justification

Materials Development and Verification	(dollars in thousands)		
	FY 2003	FY 2004	FY 2005

Mission Supporting Goals/Objectives:

Materials Development & Verification work ensures shipboard reactor plants meet Navy goals for extended warship operation by developing materials that will withstand the rigors of the harsh naval reactor plant environment—irradiation, high temperature, high pressure, and corrosion—for fifty-plus years. Submarine and aircraft carrier reactor plants are also unique in that they must operate under rapidly changing conditions as the ships maneuver and change speed.

Examining or replacing materials in an operational reactor plant is especially difficult because of system complexity and personnel radiation exposure concerns; thus, it is imperative that materials be qualified prior to Fleet use. To support reactor plant material needs, materials exhibiting desired characteristics are identified, developed, and subjected to long-term, strenuous testing and verification to ensure they will meet demands. These materials are also continuously reassessed based on evolving knowledge, and analytical and testing techniques. Test data is collected from both destructive and non-destructive surveys of prototypical specimens and materials removed from service. This information is used to develop predictive models. The ability of these models to reliably predict material performance is vital to operating plant safety and is key to qualifying materials for longer lifetimes.

An important objective of this work is to drive the costs of materials and processes to as low a level as possible, without compromising the safe operation of naval reactors.

Work in this category is divided into three areas: core and reactor structural materials, plant materials, and irradiation testing. The first two areas concern the different challenges and demands placed on materials based on their location and function. For example, fuel materials used in the reactor core must maintain high integrity to retain radioactive fission products under intense heat and irradiation during operating lifetime, and they must continue to maintain that integrity over thousands of years when eventually they are placed into a long-term spent fuel repository. The materials used in plant pressure-boundary components must maintain the high integrity of the primary coolant boundary under high stress in a corrosive environment. Irradiation testing of specimens is performed at the Advanced Test Reactor (ATR) located at the Idaho National Engineering and Environmental Laboratory (INEEL). The specimens are subsequently examined at the Naval Reactors' Expended Core Facility in Idaho and the Radioactive Materials Laboratory (RML) at the Knolls Atomic Power Laboratory to obtain data that is used to support both core and plant materials development.

Materials Development & Verification provides the high performance materials necessary to ensure naval nuclear reactor plants meet Navy goals for extended warship operation and greater power capabilities in the most economical manner possible.

Materials Development and Verification	(dollars in thousands)		
	FY 2003	FY 2004	FY 2005

I. Conduct planned development, testing, examination and evaluation of nuclear fuel systems, materials, and manufacturing and inspection methods to ensure naval nuclear reactors are able to meet Navy goals for extended warship operation.

A. Develop improved nuclear fuel, core and reactor structural materials, which extend core lifetimes up to the life of the ship, and evaluate irradiation tests of new and existing materials to verify acceptable lifetime performance and to improve analytical capabilities	**48,800**	**48,000**	**52,800**

Materials used in a reactor core as fuel, poison, cladding, and structural pieces must be capable of maintaining their physical integrity in an operating reactor environment which subjects them to the harmful effects of irradiation, pressure, corrosion, and heat. These materials are required to withstand the harsh environment of an operating reactor for decades. Naval Reactors is pursuing the development and testing of economically attractive materials with improved physical or nuclear characteristics to support core life expectations of more than 30 years. Improvements in material characteristics offer the potential for increased core lifetime, reductions in analytical conservatism, and cost savings.

Quality control is an integral part of all materials work, and manufacturing processes are developed and refined to ensure materials are produced efficiently and to stringent specifications. The ability to qualify materials for specific core applications is dependent upon fabrication, welding and other process development, as well as testing and development of predictive models to cover design applications. For example, new welding materials, combined with potentially more efficient cost-saving processes, are being evaluated for application to naval reactor manufacturing and construction. Where appropriate, manufacturing and other process developments are qualified and released for vendor use.

Materials used in long life core designs must be qualified in advance by collecting data on their performance during tests, examining their condition after testing and at end of use, and assembling the collected data into sound predictive models.

Verifiable Supporting Activities:

Materials work supporting long life core concepts, by nature, involves extended testing conducted over many years. The verifiable supporting activities described below provide examples of evaluations and tests performed each year thus representing outcomes within the continuing general scope of work.

FY 2003 Prepare for operations of improved, newly- installed fuel fabrication process.

Develop advanced semiconductor materials for thermophotovoltaic (TPV) direct energy conversion and obtain performance data of materials to improve efficiency and reduce cost of cell, module, and system designs.

Continue expended core examinations to improve understanding of zircaloy corrosion in naval cores and provide improved predictive capability.

Continue developing and implementing improved, cost effective joining techniques and processes for advanced materials, including fiber optic laser welding.

Continue long term evaluations of high-temperature, high-depletion fuel.

FY 2004 Evaluate the high temperature properties of new molybdenum alloys.

Conduct corrosion exams of USS OHIO fuel elements to validate performance of the OHIO-class submarine core.

Continue expended core examinations to improve understanding of zircaloy corrosion in naval cores and provide improved predictive capability.

Continue developing and implementing improved, cost effective joining techniques and processes for advanced materials, including fiber optic laser welding.

Continue testing, evaluating, and development of new high temperature fuel, and poison compatible with high temperature fuel.

FY 2005 Initiate operations in Fuel Development Laboratory including fuel fabrication, process and advanced element fabrication lines.

Examine and report on corrosion testing findings from Lawrence Livermore National Laboratory testing after four years of exposure. This testing supports the eventual disposal of naval spent cores in a geological repository.

Continue to provide design and field support for ECF exam equipment, including development of equipment technical manuals, user manuals, procedures, upgrades to equipment and resolution of trouble records in support of OHIO fuel examinations.

Support materials non-destructive testing research and development needs for new design equipment and major equipment modifications.

Initiate irradiation testing of high temperature molybdenum pressurized water reactor (PWR) elements in ATR.

Evaluate the pursuit of developing high temperature fuel technology for an advanced PWR application.

Materials Development and Verification

	(dollars in thousands)		
	FY 2003	FY 2004	FY 2005
B. Test and evaluate plant materials to characterize the long-term effects of the harsh operating environment and qualify improved materials and processes to ensure endurance requirements will be met………………………	**32,100**	**31,288**	**34,700**

The strength and integrity of materials used throughout the reactor plant are critical as degradation can lead to reduced performance, shorter lifetime, increased maintenance, or component failure. Consequently, Naval Reactors focuses on developing and qualifying high integrity, corrosion resistant materials that will provide performance and sufficient lifetimes to support increasingly longer lived nuclear cores. One of the leading concerns in material degradation is stress corrosion cracking. Stress corrosion cracking (SCC) is the damage potentially occurring to materials carrying high tensile loads exposed to fluids, radiation, and/or high temperatures. Other plant material concerns include embrittlement resulting from irradiation and the presence of cobalt corrosion and wear products, which increase the radiation level in the reactor compartment during maintenance operations. Development and qualification of low or non-cobalt materials are underway.

Naval Reactors employs various methods to test, evaluate, and qualify improved plant materials. Testing and evaluating plant materials provides needed science based performance measures, the ability to predict component performance, and a foundation for advanced material improvements. In addition to permitting development of cost effective remedial actions for existing Fleet problems, testing and evaluating plant materials supports advanced technologies for plants with life-of-the-ship reliability and for future high performance components. Materials that have been in service are examined to provide critical operating data on material performance and reliability. Non-destructive testing is generally less expensive and allows repeated examination of materials, as well as analysis of the material condition of components still in service; however, some key data on the strength and vulnerabilities of materials can only be obtained through destructive means. Requirements in FY 2005 increase to support SCC testing and various materials.

Verifiable Supporting Activities:

Because understanding the long term behavior of materials and phenomenon such as stress corrosion cracking (SCC) is an incremental learning process, the verifiable supporting activities described below represent milestones within the continuing overall effort.

FY 2003 Continue testing of nickel base alloys (wrought and weld metal) to verify hypotheses of SCC mechanisms for use in an advanced model for component stress corrosion cracking incorporating temperature, stress, and environmental variables to enable lifetime predictions of advanced component SCC performance.

Support studies of weld parameter changes with the objective of reducing weld residual stresses.

Materials Development and Verification	(dollars in thousands)		
	FY 2003	FY 2004	FY 2005

Conduct corrosion and cracking tests on new, potentially more robust reactor plant materials using in-situ monitoring techniques.

Continue testing and qualifying improved, wear-resistant, low cobalt materials and evaluate their application to CVN 21 and future plant types.

FY 2004 Develop joint advanced SCC modeling to develop better tools for predicting material reactions to operating plant environment. The improved predictions can potentially decrease the number of required inspections and increase the time between required inspections.

Evaluate results from post-service exam of EISENHOWER core fasteners to support fleet applications and SCC model refinement.

Conduct testing to quantify the next generation reactor vessel material margin to ensure material is more resistant to brittle fracture.

Complete development and evaluation of low cobalt valve coating materials, which reduce both wear of plant machinery and radiation emission.

Initiate preparations for a new Low Level Examination Facility (LLEF) to support irradiated plant materials and component test evaluations.

FY 2005 Continue experimental programs on nickel base alloys and incorporate understanding of environmental, material, and stress effects into the joint advanced Stress Corrosion Cracking growth model. The improved predictions can potentially decrease the number of required inspections and increase the time between required inspections.

Develop fundamental model to test stainless steel behavior for environmental cracking.

Implement non-destructive test methods to replace destructive exams in core construction.

Test thermal embrittlement of pressure vessel steel to analyze integrity of pressure vessel steel.

Complete testing of irradiated fastener material to validate penalty factors on SCC and low temperature fractures. Focused tests will address core and valve fastener performance questions beyond the current D2W assessments.

Materials Development and Verification	(dollars in thousands) FY 2003	FY 2004	FY 2005
C. Conduct irradiation testing and perform detailed examinations to provide data for material performance characterization and prediction…………………………………………...	**55,059**	**57,600**	**63,300**

Exposing reactor materials to the harsh characteristics of irradiation compounds the demands caused by other environmental factors. The Advanced Test Reactor (ATR), located at the Idaho National Engineering and Environmental Laboratory, produces very high neutron flux, which allows the effects of many years of operation in other reactor environments to be simulated in as short as one-tenth the time. Subsequent evaluations of test specimens in the Expended Core Facility and the Radioactive Materials Laboratory facilities are the main source of data on the performance of reactor fuel, poison, and structural materials under irradiated conditions.

Operation of the facility is partly funded in the Evaluation and Servicing budget category Work in the Materials Development and Verification category includes fabricating test specimens for insertion into the ATR, designing irradiation test trains to expose materials to selected reactor conditions, and conducting interim and post-irradiation detailed examinations to analyze how the material withstood reactor operating conditions. Test trains are specially engineered structures that hold material specimens in place during irradiation, and are periodically inserted and withdrawn allowing acquisition of data from a wide variety of materials and configurations.

One of the advantages of the ATR is the precision with which the power level (or neutron flux) can be adjusted at the various test positions. An individual test train's internal arrangement and location in the ATR determines exposure to specific conditions. Requirements in FY 2005 support an increase in the number of test train irradiations, examinations, and shipments between ATR and NRF.

Naval Reactors continues to develop enhanced systems for high temperature irradiation testing with precise temperature control and environmental monitoring in the ATR

Verifiable Supporting Activities:

Testing and collection of data from these tests is an ongoing, often long-term activity. The verifiable supporting activities reflect significant testing work. These activities should be viewed as a part of the overall continuing effort.

FY 2003 Design and analyze an additional Multiple Irradiation Capsule Experiment (MICE) test train.

Increase the MICE work scope; the focus will be on improved real time neutron flux monitoring, the feasibility of obtaining accurate in-pile dimensional, thermal conductivity, and corrosion film measurements.

Develop and demonstrate advanced techniques for monitoring in-pile test specimens.

Materials Development and Verification	FY 2003	FY 2004	FY 2005

(dollars in thousands)

Continue transient testing on alternate model fuel elements.

Continue irradiation of vendor-produced specimen of advanced fuel to qualify high integrity fuel for advanced reactor cores.

Continue long-term examination of irradiation tests to improve understanding of zircaloy corrosion and oxide blistering.

Remove RML in-cell waste to allow for increased evaluation capability.

FY 2004 Continue to establish the processes to qualify new fuel and cladding materials and manufacturing methods for advanced concepts core designs.

Continue MICE testing and manufacture irradiation test specimens.

Obtain data on irradiated fuel, poison, clad structural materials for use on current and advanced cores.

Continue transient testing on alternate model fuel elements.

FY 2005 Continue studies of fuel and cladding performance. These advanced examination techniques will be developed and deployed for high temperature fuel and structural materials.

Provide technical work documents and direction to assemble, disassemble, examine and ship irradiated tests between ATR and NRF.

Implement tests train cask containers, which are used to ship irradiated test specimens between ATR and NRF.

Continue to obtain data on irradiated fuel, poison, and clad and structural materials for use on current and advanced core.

Utilize assembly/disassembly table at ATR to handle test trains without need for transportation of table to ECF.

Total, Materials Development and Verification ……..	**135,969**	**136,888**	**150,800**

Detailed Program Justification

Evaluation and Servicing	(dollars in thousands)		
	FY 2003	FY 2004	FY 2005

Evaluation and Servicing work encompasses the operation, maintenance, and servicing of land-based prototype naval nuclear propulsion plants and the Advanced Test Reactor (ATR). It also includes the enhancement of Fleet reactor reliability and longevity through testing and examination of reactor materials, components, and new designs under prototypical operating conditions. Other important work funded by Evaluation and Servicing is the development of a spent fuel dry storage facility that will be integral to moving spent nuclear fuel from water pit storage to more environmentally benign dry storage at the Naval Reactors Facility (NRF), and remediation and environmental work at all Naval Reactors sites.

Evaluation and Servicing supports the performance measures for ensuring maximum availability of prototype plants in order to test and train safely; to responsibly inactivate already shutdown prototype plants; to operate test facilities to support Navy goals for extended warship operation, and to maintain excellence in radiological and environmental control.

Keeping the prototype plants, the Advanced Test Reactor (ATR), and Idaho Expended Core Facility (ECF) running efficiently is essential, as information obtained from testing provides valuable feedback for designing new cores and supporting operating Fleet reactor plants. Testing of materials, components, cores, and systems in these reactor plants provides important technical data and experience under actual operating conditions, thereby avoiding potential costly delays when designs are later inserted into the operating Fleet.

The accumulation of operational data from the prototype and Fleet operating plants, expended core examinations, and increases in the capability of computer modeling have enabled Naval Reactors to shut down six of the Program's eight prototype plants resulting in substantial cost savings. Work is aimed at dismantling and laying up the shutdown plants to place them in an environmentally benign state.

The Evaluation and Servicing category also funds ongoing cleanup of facilities at all Naval Reactors sites to reduce hazards to personnel, and reduce potential liabilities due to aging facilities, changing conditions or accidental releases.

	(dollars in thousands)		
Evaluation and Servicing	FY 2003	FY 2004	FY 2005

I. Maintain a utilization factor of at least 90% for prototype plants to ensure their availability for scheduled testing, training, and servicing needs, and provide for development of servicing equipment and testing of plant components, materials and procedures.

A. Operate land-based test reactor plants to provide for prototypical testing, core depletion analysis, and reactor plant operator training	**40,200**	**42,000**	**42,000**

Naval Reactors operates the MARF and S8G prototypes on an around-the-clock basis to test and evaluate new/improved equipment, components, materials and operating procedures. Each prototype provides for testing under actual operating conditions far superior to a laboratory environment. A major objective is to aggressively deplete the advanced fleet reactor in S8G to gather data necessary to validate the design methods currently in use in both the SEAWOLF and VIRGINIA-class submarines. Additionally, the data collected is being used in the development of the CVN 21 aircraft carrier reactor as well as the next-generation submarine reactor core.

The MARF prototype is depleting the developmental materials core at varying power levels, and periodic physics tests are being performed to determine how the nuclear fuel reacts with an advanced poison material being tested in that core. These tests are conducted multiple times over the life of the core to verify predicted behaviors as the fuel depletes.

Naval Reactors performs routine preventive and corrective maintenance on the MARF and S8G prototypes, while also making necessary improvements, to ensure the plants remain in compliance with strict safety and reliability standards. Work necessary for safe, effective prototype operation includes: operating support systems essential for reactor plant operations; monitoring plant and equipment performance to ensure problems are promptly identified and resolved; performing routine radiological monitoring of plant operations and personnel radiation exposure; maintaining proper plant and support system chemistry control; replacing plant components as they age to ensure continued, reliable plant operations; and maintaining technical manuals to reflect changes in operating and test procedures.

Verifiable Supporting Activities:

FY 2003 Meet depletion objectives for MARF and S8G cores.

Conduct the fifth MARF low power physics test and various S8G high power physics tests and document results.

Upgrade site and prototype plant infrastructure including Site Service Water System modifications.

Evaluation and Servicing	(dollars in thousands)		
	FY 2003	FY 2004	FY 2005

FY 2004 Meet depletion objectives for MARF and S8G cores.

Complete Cooling Tower Maintenance in conjunction with the S8G Selected Restricted Availability (SRA).

Complete periodic integrity testing to verify continued satisfactory performance of the S8G prototype containment systems.

Conduct the seventh MARF high power physics test and various S8G high power physics tests and document results.

Test automated reactor coolant chemistry process at the S8G prototype in support of future Fleet usage. This will allow for more consistent reactor coolant chemistry, as automated adjustments are more precise than technician-measured, manual additions.

Test alternate power conversion device at MARF. When successful, this will replace motor generators in operating power plants, making power supply more reliable and easier to maintain.

FY 2005 Meet depletion objectives for MARF and S8G cores.

Perform steam generator inspection, and conduct periodic hull integrity test on the MARF prototype as part of planned shutdown periods. .

Conduct the sixth MARF low power physics test.

Perform Integrated Condition Assessment System (ICAS) testing in S8G prototype to support integration of ICAS with other enhancements thereby demonstrating automated techniques in order to reduce log-keeping burden on watchstanders while improving utility of logged data for trend analysis and maintenance.

Continue testing automated reactor coolant chemistry analysis equipment at the S8G prototype in support of future Fleet usage. This testing supports an FY05 delivery to the shipyard to support first installation in CVN 77.

Evaluation and Servicing	(dollars in thousands) FY 2003	FY 2004	FY 2005
B. Service land-based test reactor plants to ensure they continue to operate safely and efficiently, and develop equipment and procedures to provide for safe and efficient servicing of nuclear reactor plants …………..	**17,100**	**16,400**	**16,400**

In order to ensure continued safe and reliable operation of its prototype plants, Naval Reactors performs major servicing efforts according to strict timelines. A major non-refueling overhaul of the S8G prototype plant will be initiated in FY 2004 and completed in FY 2005, which includes a major inspection of key primary loop components, welds and joints. An extended shutdown of the MARF prototype plant will be completed in FY 2005, which includes a major inspection of key primary loop components. These inspections maintain the continued integrity and structural adequacy of the primary plant components and help to maintain the highest safety and operational efficiency standards.

Naval Reactors ensures that the efforts that coincide with defueling and refueling operations are considered as part of design and development of new reactor cores. Work in FY05 will focus on continuing work on the A1B reactor servicing design and developing these designs to enhance reactor fueling, maintenance and defueling capability. In addition, Naval Reactors is progressing well on the next-generation reactor servicing design to reduce servicing costs. Development of all-power-unit loading, maintenance and defueling equipment, all fueling and defueling software, planning documents, and analyses required for shipment and installation of the next-generation reactor power unit, as well as shipment and disposal of recoverable irradiated fuel and irradiated core components are all vital efforts in servicing design. This same work also is continuing for the CVN 21 reactor to ensure servicing capability through simplified operations to reduce overall CVN 21 costs.

Verifiable Supporting Activities:

FY 2003 Support A1B reactor equipment activities and evaluate reactor equipment designs to enhance reactor fueling, maintenance, and defueling capability.

Continue design work on next-generation submarine reactor maintenance software and hardware.

FY 2004 Develop A1B designs for reactor head area seal servicing to meet new core closure specifications, to include new designs for the control rod drive mechanism weld and cutting machines.

Begin a major non-refueling overhaul of the S8G prototype, including overhaul of the S8G main seawater valves, refurbishment of primary and secondary plant equipment, execution of component/weld inspections, and major upgrades to the hull insulation and weather protection system.

Perform a resin discharge at the MARF prototype.

Continue development of detailed designs for CVN 21 reactor servicing equipment.

Continue next-generation submarine reactor maintenance hardware, continue development of maintenance capability software.

FY 2005 Continue development of detailed designs for A1B reactor servicing equipment to enhance reactor fueling, maintenance, and defueling capability.

Continue development of A1B designs for reactor head area seal servicing to meet new core closure specifications for core construction. (The new designs include control rod drive mechanism weld and cutting machines).

Complete a major non-refueling overhaul of the S8G prototype (including overhaul of the S8G main seawater valves and execution of component/weld inspections of the S8G plant).

Design new shipping containers to support refueling/defueling of NIMITZ-class carriers. This new container is needed to support the dramatically increased refueling needs for NIMITZ-class carriers.

Complete next-generation submarine reactor maintenance hardware and software design.

Perform an extended shutdown of the MARF prototype (including major inspection of steam generators).

	FY 2003	FY 2004	FY 2005
C. Operate and service the Advanced Test Reactor to provide for materials irradiations testing ………………………………………..	**17,896**	**18,000**	**18,000**

As the principal customer of the Advanced Test Reactor (ATR), Naval Reactors funds operation and maintenance of the reactor to support materials irradiations testing. This is the only facility in the nation capable of performing these tests. The ATR provides the ability to irradiate six train-type experiments with various flux conditions simultaneously in both the pressurized water or flowing gas loops. Actual testing is funded in the Materials Development and Verification category.

The ATR is the source of test data on the performance of reactor fuel, poison, and structural materials under irradiated conditions. The irradiation test program supports operating naval reactor plants, material selections made for the next-generation reactor, and database development that allows Naval Reactors to better understand emergent problems with existing reactors and to make informed material selections for new reactor designs.

Verifiable Supporting Activities:

All years meet operating efficiency goals.

Evaluation and Servicing	(dollars in thousands)		
	FY 2003	FY 2004	FY 2005

II. Meet cost and schedule goals to safely and responsibly inactivate shutdown of land-based reactor plants in support of the Department's environmental clean-up goals.

A. Continue efforts at the Windsor site in Connecticut to release applicable areas for unrestricted use	**500**	**100**	**0**

The S1C plant is defueled; inactivation is complete; and all facilities have been removed from the site. Completion of process to satisfy the EPA and the State of Connecticut such that the site may be released for unrestricted future use is expected in FY 2004. Required resources decrease simultaneously as documentation of inactivation work is finalized. The site will then be released for unrestricted future use.

Verifiable Supporting Activities:

FY 2003 Continue site closeout and release process.

Continue efforts required obtaining EPA and the State agreement on unrestricted release of property.

FY 2004 Complete site closeout and release process.

Release land for unrestricted future use.

FY 2005 None.

B. Continue inactivation efforts at the Kesselring site in New York to eliminate surplus facilities, remediate and dismantle plant facilities, and release applicable areas	**12,700**	**15,200**	**15,200**

The S3G and D1G plants at the Kesselring site in New York are defueled. In 1997, an Environmental Impact Statement (EIS) and Record of Decision recommending prompt dismantlement of the S3G and D1G reactor compartments were issued. The EIS had public, state, and local government support. The S3G engine room has been completely dismantled. Ongoing site/reactor plant-related remediation work is planned for FY05 and future years. This work will reduce radiological and environmental hazard liabilities associated with historic prototype operations; however, such work is limited by funding constraints.

Verifiable Supporting Activities:

FY 2003 Complete removal, and ship out D1G pressure vessel for disposal.

	(dollars in thousands)		
	FY 2003	FY 2004	FY 2005

Continue S3G and D1G plant disassembly and disposal in accordance with the EIS Record of Decision and consistent with available funding.

FY 2004 Remove S3G primary shield tank.

Continue S3G and D1G plant disassembly and disposal in accordance with the EIS Record of Decision and consistent with available funding.

FY 2005 Continue S3G reactor compartment dismantlement.

Continue D1G reactor compartment dismantlement.

	FY 2003	FY 2004	FY 2005
C. Continue inactivation efforts in Idaho to eliminate surplus facilities, remediate and dismantle plant facilities, and release applicable areas ………………………………..	**1,800**	**400**	**400**

All fuel has been removed from the prototype plants at the Naval Reactors Facility (NRF). The prototype plants are now in a safe lay-up condition, with all plants being maintained in a low-maintenance, environmentally benign state. Based on progress to date, Program priorities, and budget constraints, minimal site/reactor plant-related remediation effort is planned for FY 2005 and future years, with additional work to be performed, as funding becomes available.

Verifiable Supporting Activities:

FY 2003 Continue preparations for the current characterization and demolition of NRF buildings no longer needed.

FY 2004 Maintain plants in environmentally benign lay-up.

Demolition of NRF buildings no longer needed.

FY 2005 Maintain plants in environmentally benign condition.

Demolition of NRF buildings no longer needed.

III. Maintain outstanding environmental performance by ensuring that no personnel exceed Federal limits for radiation exposure and ensure operations have no adverse impact on human health or the quality of the environment.

A. Conduct ongoing cleanup of site facilities to reduce potential hazards to personnel and reduce potential liabilities due to changing conditions or accidental releases ……………..	**30,589**	**40,003**	**31,910**

Operation of test, examination, and manufacturing facilities has involved the use of hazardous materials. Decontamination and unconditional release of previously contaminated facilities minimizes the potential of the environmental, health and safety impact of those facilities, with the benefit of making previous site areas available for reuse. This work reduces the potential for materials such as asbestos, heavy metals, other chemicals, or radioactivity to enter into the environment. To validate the effectiveness of remediation work, environmental monitoring and control efforts are in place to ensure compliance with all regulations at all Naval Reactors' sites.

Remediation is achieved through a deliberate multi-step process which may involve facility structures and equipment being cleaned, physically abraded, or removed according to strict engineering controls that protect personnel and the environment, and that minimize the amount of waste generated. Resultant wastes are packaged and disposed of off-site according to applicable requirements. Facilities are surveyed and sampled to verify that contamination has been removed.

Facilities and equipment are characterized to determine the extent and nature of cleanup needed. The results of these characterizations are analyzed and the work prioritized based on regulatory requirements and resources available to perform the work. As such, the order in which the following verifiable supporting activities are performed is subject to change based on this prioritization process.

Verifiable Supporting Activities:

FY 2003 Remove highly contaminated equipment from the obsolete fuel-processing facility in the L-Building at the Bettis-Pittsburgh site.

Sample, characterize, and remediate or remove, as necessary, radiological piping, tanks, sumps, pits, and other potential sources of environmental release and personnel exposure at the Bettis-Pittsburgh and KAPL-Knolls sites.

Provide engineering direction and subcontract preparation, placement, and execution for the repair and maintenance of the prototype buildings. Additionally, conduct remedial actions at NRF based on the Record of Decision.

Maintain lay-up support systems in working condition and perform environmental monitoring at the NRF site to ensure that the plants remain in a safe, environmentally benign state.

Evaluation and Servicing	(dollars in thousands)		
	FY 2003	FY 2004	FY 2005

Continue decontamination and removal of obsolete systems at ECF.

Continue decontamination and stabilization of selected Knolls site areas and removal of old test reactor facilities to reduce potential environmental liabilities.

FY 2004 Continue the removal of radiological legacy waste from Radioactive Materials Laboratory at KAPL-Knolls site.

Remove regulated materials from various buildings at KAPL-Knolls site.

Conduct remediation of obsolete facilities to reduce potential environmental liabilities at all program sites, such as the obsolete fuel facility at the Bettis-Pittsburgh site.

Develop the preliminary design efforts for establishing the infrastructure associated with the deconstruction of the Materials Evaluation Laboratory, Hot Waste Building, N-Building W4R and W5R laboratories, and piping servicing these facilities at Bettis-Pittsburgh.

Sample, characterize, and remediate or remove, as necessary, radiological piping, tanks, sumps, pits and other potential sources of environmental release and personnel exposure at the Bettis-Pittsburgh and KAPL-Knolls sites.

Continue waste processing in the Waste Reduction Facility.

Continue Comprehensive Environmental, Response, Compensation, and Liability Act (CERCLA) remediation work at NRF site.

Continue environmental sampling and remediations at the KAPL-Knolls site.

FY 2005 Complete CERCLA remediation work at NRF.

Continue decontamination and disposition of the A1W Quench Tanks at NRF.

Plan decontamination of Water Pit #1 at NRF.

Plan for the dismantlement and disposal of Building 29, at the Kesselring Site, which includes three Solid Waste Management Units. Building 29 is an inactive wastewater collection system formally used by the S3G Prototype.

Perform decontamination and decommissioning of inactive facilities at all sites, including the obsolete fuel facility at Bettis-Pittsburgh, the Equipment Pit at NRF, and the Radioactive Materials Laboratory at KAPL-Knolls.

Plan and prepare for future deconstruction of the Materials Evaluation Laboratory, Hot Waste Building, N-Building W4R and W5R laboratories, and piping servicing of these facilities at Bettis-Pittsburgh.

Gather and evaluate sample chemical and radiological data at all sites. These evaluations are in compliance with Naval Reactors Program and RCRA requirements.

Perform RCRA remediation at Knolls, Kesselring and Bettis.

Support DOE Oakland Office preparations for the remediation of the former fissionable materials reprocessing facility, Separations Process Research Unit (SPRU).

IV. Conduct planned development, testing, examination and evaluation of nuclear fuel systems, materials, and manufacturing and inspection methods to ensure naval nuclear reactors are able to meet Navy goals for extended warship operation.

	FY 2003	FY 2004	FY 2005
A. Examine removed fuel cells at end-of-life and perform non-destructive examinations of irradiated test specimens to confirm predicted performance and validate design methods …..	**31,190**	**37,590**	**48,090**

This effort concentrates on the examination of expended reactor cores and irradiated test specimens to provide data necessary for further operation of nuclear reactors in the fleet and future generation of nuclear reactors. The results of these examinations are used to reduce uncertainties in behavior of cores and components, to produce improvements in existing ship performance, and to extend reliable operational life. Predictive and analytical tools are updated based on differences between calculations and observed performance and are used to ensure the safety and improve the performance of reactor designs. This effort also provides for the development of new servicing systems required to temporarily store naval fuel at the Expended Core Facility (ECF) in Idaho and the eventual transfer of fuel to a permanent geologic repository. Current development efforts include the development of spent fuel dry storage capability, the conversion of ECF operations to be in accordance with the Naval Reactors Program standards and documentation requirements, and development of the systems required to safely transport and dispose of spent naval fuel in the permanent geologic repository.

Verifiable Supporting Activities:

FY2003 Provide waste disposal and shipping support for NRF.

Assemble, disassemble, and ship approximately 24 irradiated test assemblies between NRF and ATR.

Perform examinations of A1G/A4W and D2W core components.

Perform design and analysis of new equipment to establish production dry storage capability for spent naval fuel. This includes most of the major equipment designs, such as shielded basket transfer container, shield door, etc.

Initiate spent fuel dry storage at NRF.

FY 2004 Provide support for the establishment of production dry storage capabilities for spent naval fuel by evaluating materials and fuel elements to ensure they do not release fission products under environmental conditions found in the repository.

Provide general project support to prepare for and execute ECF construction projects.

Perform nuclear criticality and safety analyses to ensure configurations of moving and stored fuel elements meet safety standards.

Provide support for shipping of all hazardous and radioactive waste from NRF.

Perform design and analysis of remaining equipment to support startup of the production dry storage system at NRF. Perform design and analysis of equipment used for continued dry storage operations (e.g. baskets, grapples and control rod attachment equipment).

Perform design and analysis of new equipment to support initial shipments from INTEC to NRF for dry storage, such as baskets, grapples and supplemental nuclear poison equipment.

Perform design and analysis of new equipment for shipment of naval spent fuel to the geological repository. This includes transportation casks and cask lifting equipment.

FY 2005 Perform design and analysis of equipment used for continued dry storage operations (e.g. baskets, grapples and control rod attachment equipment).

Perform design and analysis of new equipment to support continued shipments from INTEC to NRF for dry storage, such as baskets, grapples and supplemental nuclear poison equipment.

Perform design and analysis of equipment to be used to ship spent fuel canisters to the national repository (e.g. transportation cask, cask-lifting equipment).

Design new underwater cutting equipment to support the dry storage of naval spent fuel.

Evaluation and Servicing	FY 2003	FY 2004	FY 2005
	(dollars in thousands)		

Assemble, disassemble, and ship approximately 25 irradiated test assemblies between NRF and ATR.

Continue examination of S8G core components and commence fastener examinations.

Total, Evaluation and Servicing ……………………...	**151,975**	**169,693**	**172,000**

Explanation of Funding Changes

	FY 2005 vs. FY 2004 ($000)
▪ **Plant Technology**	
I. A. Requirements increase to support the design for TTC	+ 12,100
I. B. Requirements increase as efforts are intensified to develop I&C equipment specifications for CVN 21 and TTC	+ 13,000
I.C. Requirements decrease because reactor plant component testing completed in FY 2004	- 225
▪ **Reactor Technology and Analysis**	
I. A. Funding level reflects increased A1B core manufacturing development	+ 2,885
I. B. Funding level reflects decreased TTC core manufacturing development	- 4,400
▪ **Materials Development and Verification**	
I. A. Requirements reflect an increase to support work at NRF	+ 4,800
I. B. Requirements reflect an increase in SCC testing and various materials	+ 3,412
I.C. Requirements reflect an increase due to increase number of Test Train irradiations, examinations, and shipments between ATR and NRF	+ 5,700
▪ **Evaluation and Servicing**	
II. A. Decrease due to completion of all site remediation.	- 100
III. A. Decrease due to delayed remediation efforts at Program facilities	- 8,093
IV. A. Increase due increased efforts to support moving from wet storage to dry storage at NRF	+ 10,500
▪ **Facility Operations**	+ 2,796
Total Funding Change	**+ 42,375**

Capital Operating Expenses & Construction Summary

Capital Operating Expenses

(Dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
General Plant Projects	15,690	12,900	17,400	+ 4,500	+ 34.9%
Capital Equipment	25,796	35,115	33,411	- 1,704	- 4.9%
Total, Capital Operating Expenses ..	41,486	48,015	50,811	+ 2,796	+ 5.8%

Construction Projects

(dollars in thousands)

	Total Estimated Cost (TEC)	Prior Year Appropriations	FY 2003	FY 2004	FY 2005	Unappropriated Balances
Naval Reactors						
90-N-102 Core Facility Dry Cell	109,379	88,211	1,987	18,192	989	0
01-D-200 Major Office Replacement Building.................	12,383	10,297	2,086	0	0	0
03-D-201 Cleanroom Technology Facility..................	7,451	0	7,153	298	0	0
05-D-900 Materials Development Facility..................	17,400	0	0	0	6,200	11,200
Total, Construction..........		98,508	11,226	18,490	7,189	11,200

Major Items of Equipment *(TEC $2 million or greater)*

(dollars in thousands)

	Total Estimated Cost (TEC)	Prior-Year Appropriations	FY 2003	FY 2004	FY 2005	Acceptance Date
Network Upgrade	2,800	0	0	1,000	1,000	FY 2006
Low Level Exam Equipment	5,100	0	0	320	3,970	FY 2006
Scalable Parallel Supercomputer	2,000	0	2,000	0	0	FY 2003
Scalable Parallel Supercomputer	8,000	0	0	8,000	0	FY 2004
High Performance Technical Computing System	8,200	0	0	0	8,200	FY 2005
Network Convergence	3,000	0	0	0	800	FY 2006
Total, Major Items of Equipment		0	2,000	9,320	13,970	

Program Direction

Funding Profile by Category

(dollars in thousands/whole FTE's)

	FY 2003 Comp Approp	FY 2004 Comp Request	FY 2005 Request	$ Change	% Change
Program Direction					
Headquarters					
Salary and Benefits.................	8,525	8,992	10,200	+ 1,208	+ 13.4%
Travel......................................	530	550	560	+ 10	+ 1.8%
Support Services.....................	0	0	0	0	0.0%
Other Related Expenses.........	903	2,067	2,990	+ 923	+ 44.7%
Total, Headquarters................	9,958	11,609	13,750	+ 2,141	+ 18.4%
Full Time Equivalents	57	60	70	+ 10	+ 16.7%
Pittsburgh Naval Reactors					
Salary and Benefits	6,655	7,029	7,434	+ 405	+ 5.8%
Travel......................................	130	135	142	+ 7	+ 5.2%
Support Services.....................	0	0	0	0	0.0%
Other Related Expenses.........	970	1067	1,172	+ 105	+ 9.8%
Total, Pittsburgh Naval Reactors....................	7,755	8,231	8,748	+ 517	+ 6.3%
Full Time Equivalents..............	70	70	70	0	0.0%
Schenectady Naval Reactors					
Salary and Benefits.................	5,625	6,065	6,337	+ 272	+ 4.5%
Travel......................................	95	106	108	+ 2	+ 1.9%
Support Services	0	0	0	+ 0	0.0%
Other Related Expenses.........	610	541	557	+ 16	+ 3.0%
Total, Schenectady Naval Reactors.....................	6,330	6,712	7,002	+ 290	+ 4.3%
Full Time Equivalents..............	64	64	64	0	0.0%
Total Naval Reactors Program					
Salary and Benefits.................	20,805	22,086	23,971	+ 1,885	+ 8.5%
Travel......................................	755	791	810	+ 19	+ 2.4%
Support Services.....................	0	0	0	0	0.0%
Other Related Expenses.........	2,483	3,675	4,719	+ 1,044	+ 28.4%
Total, Program Direction	24,043 [a]	26,552 [b]	29,500	+ 2,948	+ 11.1%
Full Time Equivalents.....	191	194	204	+ 10	+ 5.2%

[a] This reflects a $157,000 rescission.
[b] This reflects a $148,000 rescission.

Description

Due to the critical nature of nuclear reactor work, Naval Reactors is a centrally managed organization. This places a heavy burden on the Federal employees who oversee and set policies/procedures for developing new reactor plants, operating existing nuclear plants, facilities supporting these plants, contractors, and the Bettis and Knolls Atomic Power Laboratories. In addition, these employees interface with other DOE offices and local, state, and Federal regulatory agencies.

The FY 2005 request includes requirements to support a full time equivalent increase of ten personnel to the Naval Reactors Program.

Detailed Justification

	(dollars in thousands)		
Program Direction	FY 2003	FY 2004	FY 2005
Salaries and Benefits	**20,805**	**22,086**	**23,971**

Federal Staff continue to direct technical work and provide management/oversight of laboratories and facilities to ensure safe and reliable operation of Naval nuclear plants. The change is due to projected salary adjustments in accordance with allowable inflation and achieving FTE target in FY05.

Travel	**755**	**791**	**810**

Travel includes funding for the transportation of Government employees, their per diem allowances while in authorized travel status and other expenses incidental to travel. FY 2005 funding supports travel required for the management and oversight of the Naval Reactors Program, in addition to inflationary growth between FY 2005 and FY 2004.

Support Services	**0**	**0**	**0**

Naval Reactors does not use Support Services contractors.

Other Related Expenses	**2,483**	**3,675**	**4,719**

Includes provision of funds for the Working Capital Fund, based on guideline estimates provided by the Working Capital Fund Manager. Funding also supports goods and services such as training and ADP maintenance, and includes labor costs for Bettis contractor services and ADP requirements for NR Headquarters' internal classified local area network.

Total, Program Direction	**24,043**[a]	**26,552**[b]	**29,500**

Explanation of Funding Changes

	FY 2005 vs. FY 2004 ($000)
▪ **Salaries and Benefits**	
The change is due to salary adjustments in accordance with allowable inflation and achieving FTE target in FY 2005	+ 1,885
▪ **Travel**	
The change is due to adjustments in accordance with allowable inflation	+ 19
▪ **Other Related Expenses**	
The change is due to increases in the number of personnel supported by headquarters and adjustments in accordance with allowable inflation	+1,044
Total Funding Change, Program Direction	**+ 2,948**

Other Related Expenses

(Dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
Training	137	160	185	+ 25	+ 15.6%
Working Capital Fund and Rent	560	570	580	+ 10	+ 1.8%
Software Procurement/Maintenance Activities/ Capital Acquisitions	860	1,234	1,644	+ 410	+ 33.2%
Other	926	1,711	2,310	+ 599	+ 35.0%
Total, Budget Authority	2,483	3,675	4,719	+ 1,044	+ 28.4%

05-D-900, Materials Development Facility Building, Schenectady, New York

1. Construction Schedule History

	Fiscal Quarter				Total Estimated Cost ($000)	Total Project Cost ($000)
	A-E Work Initiated	A-E Work Completed	Physical Construction Start	Physical Construction Complete		
FY 2005 Budget Request	1Q2005	4Q2005	4Q2005	4Q2008	17,400	20,350

2. Financial Schedule

(dollars in thousands)

Fiscal Year	Appropriations	Obligations	Costs
Design/Construction			
2005	6,200	6,200	2,500
2006	9,900	9,900	8,000
2007	1,300	1,300	6,400
2008	0	0	500

3. Project Description, Justification and Scope

A replacement industrial facility building is planned for construction at Knolls Atomic Power Laboratory (KAPL) to consolidate non-irradiated material development fabrication and characterization activities, which are currently located in five separate buildings, and to reduce life cycle cost. A detailed study found constructing a new building vice renovation and expansion of the existing buildings, which date back to the 1950's, is a more cost-effective method of maintaining these critical Program capabilities and over the next 30 years will yield a projected 22% life cycle cost savings. Due to historical radiological and hazardous materials contamination, existing facilities require decontamination prior to eventual demolition, which will reduce historical contamination liability.

The building will provide state-of-the-art industrial space and will be constructed to the latest energy efficiency and safety standards and will make use of low maintenance materials to minimize future cost. The building will be a two-story structure providing high bay, medium bay, laboratory space, and an open office layout to provide professional spaces for the technical and administrative personnel. The building's electrical and mechanical needs will be provided by a new double-ended load center and a 400-ton chiller to be located in the adjacent office building. The project will also purchase new equipment; however most of the equipment will be moved into the facility from existing facilities. KAPL has evaluated several alternatives including construction of a smaller building and a one-story building. All of these alternatives have higher life cycle costs and do not meet laboratory needs.

FY 2005 construction funds will be used for site preparation work, including demolition of existing facilities, modifications to existing site utilities, and final design of the building.

FY 2006 construction funds will be used to construct the building.

FY 2007 construction funds will be used to complete outfitting of the building.

This new facility will provide sufficient industrial space to house the Materials Fabrication Facility, the Component Fabrication Facilities, the Materials Characterization Laboratory, and the Science Autoclave Facility and will consolidate materials/fabrication laboratory efforts into one facility.

4. Details of Cost Estimate[a]

(Dollars in thousands)

	Current Estimate	Previous Estimate
Design Phase		
Preliminary and Final Design costs (Design drawings and Specifications).................	730	0
Design Management costs (1.0% of TEC)	180	0
Project Management costs (0.1% of TEC)	25	0
Total, Engineering design inspection and administration of construction costs (5.4% of TEC)...	935	0
Construction Phase		
Buildings	8,700	0
Utilities (Electrical/Civil)	3,970	0
Standard Equipment (Modular Furniture/Office Equipment)	555	0
Removal less salvage	375	0
Inspection, design and project liaison, testing, checkout and acceptance..................	335	0
Construction Management (5.1% of TEC)...	895	0
Project Management (0.5% of TEC)..	95	0
Total, Construction Costs	14,925	0
Contingencies		
Design Phase..	70	0
Construction Phase (8.4% of TEC)	1,470	0
Total, Contingencies (8.9% of TEC)...	1,540	0
Total, Line Item Cost (TEC)	17,400	0

5. Method of Performance

Contracting arrangements are as follows:

Building design/construction will be accomplished via one fixed price (design/build) contract awarded on the basis of competitive proposals (price to be the major factor). Utility installations, demolition security/roadway work, and major equipment installations will be performed using conventional competitive contracting methods.

[a] The cost estimate is based on conceptual design estimates.

6. Schedule of Project Funding

	Prior Years	FY 2004	FY 2005	FY 2006	Outyears	Total
Project Costs						
Facility Costs						
Design	0	0	200	735	0	935
Construction	0	0	2,300	7,265	6,900	16,465
Total, Line Item TEC	0	0	2,500	8,000	6,900	17,400
Preliminary Engineering Design Cost	0	393	7	0	0	400
Other Project Costs	0	0	50	131	919	1,100
Conceptual Design Cost	300	50	0	0	0	350
Decontamination and Decommissioning	0	90	810	200	0	1,100
Total, Other Project Costs	300	533	867	331	919	2,950
Total Project Cost (TPC)	300	533	3,367	8,331	7,819	20,350

7. Related Annual Funding Requirements

(dollars in thousands)

	Current Estimate	Previous Estimate
Annual facility operating costs [a]	861	861
Utility costs (estimate based on FY 2002 rate structure)[b]	729	729
Total related annual funding	1,590	1,590
Total operating costs (operating FY 2008 through FY 2038)	67,383	67,383

[a] Includes personnel and M& R cost (exclusive of utility cost) for operation, maintenance, and repair of the MDF.

[b] Including utility cost for operation of the MDF which will begin in FY 2008.

90-N-102, Expended Core Facility Dry Cell, Naval Reactors Facility, Idaho

1. Construction Schedule History

	Fiscal Quarter				Total Estimated Cost ($000)	Total Project Cost ($000)
	A-E Work Initiated	A-E Work Completed	Physical Construction Start	Physical Construction Complete		
FY 1990 Budget Request *(Preliminary Estimate)*..........	1Q 1990	3Q 1991	3Q 1991	4Q 1995	48,800	49,936
FY 1996 Budget Request[a]	1Q 1990	4Q 1991	2Q 1993	4Q 1998	48,646	51,027
FY 1998 Budget Request[b]	1Q 1990	2Q 1999	2Q 1993	4Q 2001	62,046	79,604
FY 1999 Budget Request[c]	1Q 1990	2Q 2000	2Q 1993	4Q 2002	84,946	96,117
FY 2000 Budget Request[d]	1Q 1990	2Q 2000	2Q 1993	4Q 2002	86,846	98,694
FY 2002 Budget Request[e]	1Q 1990	2Q 2000	2Q 1993	4Q 2002	88,246	99,907
FY 2003 Budget Request[f].....	1Q 1990	2Q 2000	2Q 1993	2Q 2006	109,500	120,883
FY 2004 Budget Request[g]	1Q 1990	2Q 2000	2Q 1993	2Q 2006	109,379	120,826
FY 2005 Budget Request[h]	1Q 1990	4Q 2004	2Q 1993	1Q 2007	109,379	120,826

[a] Reflects changes due to a June 1993 Court Injunction which placed the Dry Cell Project on hold, until an agreement was reached between the Department of Energy and State of Idaho in October, 1995.

[b] Added the East End Modification to accommodate Dry Fuel Storage.

[c] Added the West End Modification to accommodate return of spent fuel from the Idaho Nuclear Technology and Engineering Center (INTEC) to the Expended Core Facility.

[d] Included additional funding to perform design and facility modifications to accommodate the potential use of a larger fuel module within the Dry Cell.

[e]Realigned contingency based on 45% completion of the West End Modification Title II Design. In addition, the TEC and schedule reflect completion of the West End Modification Title I Design.

[f]Reflects work scope changes necessary to address radiological contamination control and facility throughput issues.

[g]Reflects Congressional FY03 rescission of $13,000 and FY04 rescission of $108,000.

[h]Reflects updated project completion date based on further definition of the design changes needed to address radiological contamination and facility throughput issues.

2. Financial Schedule

(dollars in thousands)

Fiscal Year	Appropriations	Obligations	Costs
Design/Construction			
1990	3,546	3,546	1,564
1991	4,000	4,000	3,129
1992	15,000	15,000	4,238
1993	13,600	13,600	10,078
1994	0	0	2,410
1995	0	0	555
1996	3,000	3,000	7,557
1997	8,000	8,000	13,908
1998	3,100	3,100	5,559
1999	5,800	5,800	2,825
2000	12,000	12,000	11,661
2001	15,965	15,965	8,064
2002	4,200	4,200	942
2003	1,987	1,987	1,297
2004	18,192	18,192	4,785
2005	989	989	11,097
2006	0	0	14,162
2007	0	0	5,548

3. Project Description, Justification and Scope

When all phases are completed, the Expended Core Facility (ECF) Dry Cell Project will consist of shielded fuel handling, dry storage loading facilities, an area for overpack assembly, an interim storage pad, and two dry storage container loading stations.

Two independent basket-loading areas will be installed in the ECF water pits. Features of the loading facility include the water pit to dry cell delivery system, a shielded basket transfer system, two basket loading stations and two prepared fuel loading stations. The revised systems will use proven fuel handling practices that are consistent with those used throughout the Naval Reactors Program. The complete facility will have a design life of at least 40 years.

The Dry Cell Project consists of three separate tasks: the Dry Cell, the East End Modification, and the West End Modification. The Dry Cell task provides work areas and equipment needed to more efficiently handle expended nuclear cores. This task is being modified due to concerns for the ability to repair the highly radiologically contaminated in-cell equipment, lack of redundancy in the process and the resulting impact on throughput. Spent Naval Nuclear Fuel will be loaded into Spent Fuel Canister (SFC) baskets in the ECF water pits. Two basket-loading areas will be installed in the ECF water pits. Loaded baskets will be transferred in a shielded basket transfer container to one of two prepared fuel loading stations and loaded into a SFC.

The East End Modification task provides facilities and equipment for loading dry storage containers. An interim storage pad will be provided for in-process handling, staging, and interim storage of Naval spent nuclear fuel. An area for assembly of overpacks will be constructed adjacent to the interim storage pad. The overpack assembly area and interim storage pad will add an additional 35,000 square foot structure separate from the existing ECF building. This task is approximately 61 percent[a] complete.

The West End Modification task is for the design and fabrication of the equipment and facilities for the second prepared fuel-loading station, and for receiving fuel returned from INTEC that will also be loaded into SFCs. The West End Modification will provide sufficient crane capacity and rail shipping capability to allow future loading of the SFC Shipping Cask for shipment to a permanent repository. The West End Modification task will result in an approximately 21,000 square foot addition to the existing ECF building. This task is approximately 24 percent complete.

A two loading station arrangement will allow processing fuel returned from INTEC in the West End Loading Station while concurrently processing spent fuel received directly from the fleet for dry storage in the east loading station. The increased capacity of the overall Dry Cell will facilitate a more rapid return of spent fuel from INTEC. In addition, the arrangement allows future packaging of special case waste through one of the loading stations without interruption of dry storage container loading.

An independent review of the final design identified potential adverse fuel handling and throughput issues. The review team found that while the planned process which included dry processing and dry storage lines is viable, concerns arose regarding sustaining the long-term spent fuel throughput needed to meet the court-enforceable obligation to move all spent fuel from wet storage to dry storage by 2023. This throughput concern is driven by potential single point failures and radiological vulnerabilities that would be extremely difficult to overcome. The project is being modified to incorporate shielded fuel handling and a new dry storage overpack loading station. These improvements will increase fuel handling capability, facility accessibility from a radiological viewpoint, equipment maintenance, and will ensure the Program can meet the required throughput over the next two decades.

The project is scheduled to complete in February 2007. Through FY 2003, 67% of the project is completed.

[a] Adjusted from 96 percent based additional funds received in FY03 to accommodate work scope changes indicated in section 1.

4. Details of Cost Estimate[a]

	(dollars in thousands) Current Estimate	Previous Estimate
Design Phase		
Preliminary and Final Design cost ($5,663,000 for Design Drawings and Specification)	15,387	15,387
Design Management costs (2.8 % of TEC)	3,059	3,059
Project Management costs (2.7 % of TEC)	2,945	2,850
Total, Engineering design, inspection, and administration of construction costs (19.5% of TEC)	21,391	21,296
Construction Phase		
Buildings	54,906	43,014
Special Equipment	11,883	19,926
Standard Equipment	5,727	5,727
Inspection, design and project liaison, testing, checkout, and acceptance	9,232	9,232
Project Management (3.1% of TEC)	3,432	2,850
Total, Construction Costs	85,180	80,749
Contingencies		
Design Phase (0.5% of TEC)	559	1,491
Construction Phase (2.1% of TEC)	2,249	5,964
Total, Contingencies (2.7% of TEC)	2,808	7,455
Total, Line Item Costs (TEC)	109,379	109,500

The cost estimate is based on the Dry Cell task being complete, the East End Modification task Title II design being complete and the West End Modification task Title II design being complete.

5. Method of Performance

Contracting arrangements are as follows:

a. Construction design will be performed under an Engineering Services Subcontract. Equipment will be designed by the prime contractors.

b. Construction and procurement will be accomplished by fixed price contracts awarded on the basis of competitive bidding.

[a] The annual escalation rates assumed for FY 2004, FY 2005, FY 2006 and FY 2007 are 2.5%, 2.9%, 2.8% and 2.6%, respectively.

c. Title III Support: By Engineering Services Subcontractor under operating contractor surveillance.

6. Schedule of Project Funding

	Prior Years	FY 2003	FY 2004	FY 2005	Outyears	Total
Project Costs						
Facility Costs						
Design	19,196	438	1,158	1,158	0	21,950
Construction	53,294	859	3,627	9,939	19,710	87,429
Total, Line Item TEC	72,490	1,297	4,785	11,097	19,710	109,379
Operating expense funded equipment[a]	4,351	0	0	0	0	4,351
Total Facility Costs	76,841	1,297	4,785	11,097	19,710	113,730
Other Project Costs						
Conceptual Design Cost	1,601	175	0	0	0	1,776
Decontamination & Decommissioning[b]	1,184	0	0	0	0	1,184
NEPA Documentation Costs	2,500	0	0	0	0	2,500
Other project-related costs[c]	1,286	50	50	100	150	1,636
Total, Other Project Costs	6,571	225	50	100	150	7,096
Total Project Cost (TPC)	83,412	1,522	4,835	11,197	19,860	120,826

[a] Includes costs for adaptation of existing storage overpacks for the selected Naval Spent Fuel Canisters (NSFCs); development of container welding systems; and procurement of weld mockups and two sets of NSFCs and overpacks for facility and system testing and checkout. Prior Years figures include costs of $50,000 and $100,000 respectively for the design and fabrication of the temporary west shield wall.

[b] Prior Years figures include costs for removal of the spray pond and Butler Buildings 10 and 10A.

[c] Includes costs for procurement of several prototype items to support equipment design and confirm system operations, for facility startup, and for operator training.

7. Related Annual Funding Requirements

	(dollars in thousands)	
	Current Estimate	Previous Estimate
Annual facility operating costs[a] ………	4,506	4,506
Annual facility maintenance and repair costs ………	0	0
Programmatic operating expenses directly related to the facility ………	0	0
Utility costs[b] ………	574	574
Total related annual funding………	5,080	5,080
Total operating costs (operating FY2002 through FY2042) ………	203,200	203,200

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a Includes personnel, materials, and capital equipment costs for operation, maintenance, and repair.

[b] Includes electrical power, steam heat, and maintenance items such as utility lines, valves, and pumps.